THURSDAY, JANUARY 12, 1899.

THE DEVELOPMENT OF RESEARCH.

The Discharge of Electricity through Gases. By Prof. J. J. Thomson, D.Sc., F.R.S. Pp. 203. (Westminster: Archibald Constable and Co., 1898.)

THIS work is an expansion of a series of lectures delivered at the University of Princeton, New Jersey, U.S.A., in October 1896. This practice of the American universities of inviting distinguished authorities to deliver courses of lectures is an admirable one. Lord Kelvin's Baltimore lectures were delivered under similar auspices, and it is to be hoped that the promised publication of these most interesting lectures will soon take place. By thus bringing our greatest living authorities into personal relations with the staff and students of a university an energetic stimulus is given to their studies and investigations. It might be said that the local staff and students can, if they wish, read the works of any authorities they desire to study. This is no doubt true, and it makes it now possible for each university by producing new knowledge to teach all the world, and not only those who come to reside in its vicinity. Thus the real students of each university are now spread all over the world and not confined to its precincts, as they were before the reproduction and distribution of thought was as easy a matter as it is to-day. And this is a great and important duty for universities, this producing and teaching new knowledge to mankind, but it is not their only duty. They should produce investigators and discoverers as well as investigations and discoveries. Under existing conditions, investigations and discoveries in the borderlands of science cannot reasonably be expected to lead to immediately useful results to mankind. They may be most useful to our grandchildren, but one cannot reasonably expect the ordinary motives of self-interest, to which the greater part of the good work of the world is due, to produce great work which may be of use to other people's grandchildren. For the production of such work, society, which has the greatest interest in the matter, must depend upon other motives for the production of great discoveries in pure science. The motives and abilities that must here be depended on do not exist in at all the same proportion of mankind as self-interest and that general ability to carry out rules which is sufficient for so much of the world's work. Enthusiastic devotion to the investigation and discovery of what is true, and the intellectual acuteness required for its successful pursuit, are not of common occurrence, and in a great many cases without special encouragement and training will, even in those who are capable of having these capacities highly developed, be overpowered by the distractions of other motives claiming attention to other fields of work. It is an important duty for universities to seek out those in whom it is possible to develop these motives and abilities; to encourage them to cultivate these abilities, and to strengthen in every way the hold of these motives on them. Almost the only way in which such motives can be strengthened is by the sympathetic encouragement of those who are already enthusiastic investigators and discoverers. That this is a really successful way of producing the character desired is fully proved by the existence of *disciples* in every branch of human endeavour that involves enthusiastic devotion of life. How is it that so many of the passing generation of chemical discoverers have been workers in the laboratories of Liebig, for example? The proportion of chemists who studied with Liebig to the whole body of those who have studied chemistry is very small indeed, but the proportion of leaders of chemical discovery who have studied under Liebig to the whole number of leaders of chemical discovery is quite large. Why? Because Liebig's example was catching, his personality was inspiring, his enthusiasm begot enthusiasm in his pupils; they became more than pupils, they became disciples.

It is in pursuit of this end that the American universities desire to bring their staff and students into personal relations with the leaders of thought. Though there is every prospect that they soon will be, they are not yet rich enough to control the market of English-speaking thought production by making permanent appointments, but they can and do provide for a temporary residence of a leader of thought amongst them. They do what they can to bring themselves into personal relations with those who are likely to stir their enthusiasm for research into useless truth, and thus strengthen the motive which distinguishes investigators and discoverers of the kind universities should produce.

These lectures are eminently inspiring. They are full of the seed from which discovery springs, of those sign-posts on the borderlands of the known which point out directions in which further knowledge is required. They call attention to important investigations now in progress, to the results so far achieved and to the results, too, that are still only probable and require further investigation. We do not generally get this in a book. We may find it in published papers, but we should find it in lectures delivered for the purpose of directing and encouraging the researches of others. So much of this is of only ephemeral value, though, like our dinners, of enormous importance for each day's work, that it is not usually published in book form nor often in scientific papers, notwithstanding such an illustrious example as Faraday. Working hypotheses, suggestions for work, all these may turn out wrong, or useless for further advance, but may be a very necessary part of the means of advancing. We eat much that we cannot assimilate in our dinners: it is a necessary concomitant of our food, and a reasonable quantity of it is possibly necessary for the satisfactory working of our organisms. Be that as it may, the question of real importance in working hypotheses is not so much, were they true, as, did they lead to advance towards truth. Very few, indeed, who have not suggested many wrong working hypotheses have advanced truth at all, and still fewer have had enthusiastic disciples.

In these lectures we have studies of the possible causes of atmospheric electricity depending on electro-superficial double layers, a subject deserving most careful investigation; studies of a remarkable penetration of kathode ray actions through such thick conductors that Lenard rays seem out of the question, and that raises the important question of the continuity or otherwise of the

discharge in gases; studies of the mysterious photo-electric effects at the surface of bodies and throughout the body of a gas, and that cloud-producing action which seems to provide us with the opportunity of isolating electrons, obtaining a drop of liquid with only one of these upon it; studies of kathode rays and of the velocity of the electric carriers in them. The argument by which, in this concluding study, there is an attempt to prove that these cannot be either larger than molecules, nor of a comparable size, is not particularly conclusive. Among the reasons given for concluding that these carriers are not larger, it is assumed that the resistance to their motion would obey the laws of motion of a body moving slowly through a viscous medium. This is not at all true of a minute projectile moving with a velocity of at least one hundred times the velocity of the molecules of the gas. To such a projectile the gaseous molecules would be practically at rest, and the resistance would be, as Lenard observed, proportional to the density of the gas. The argument against their being of a size about the same as that of the other gaseous molecules depends on the assumption that the effective size of a molecule is independent of its rate of motion, a conclusion which is at variance with the known laws of diffusion of gases at various temperatures, and is contrary to such a probable hypothesis as that the actions between molecules is more like that between centres of force with rapidly changing forces near them than like that between hard spheres. For a comet to be deflected by a given amount when going near the sun, it should pass much closer to the sun if its velocity is large than if its velocity is small. The effective size of the sun as a deflecting cause for comets very largely depends on the velocity of the comet. On these principles rapidly moving molecules might go much further through a gas than the free path of an ordinary molecule. When the disagreement between the theory of hard spheres and the observed laws of diffusion at different temperatures is measurable, and it only corresponds to alterations of velocity to about twice the normal, we may naturally expect great variations when dealing with velocities of about one hundred times the normal, which would correspond to a temperature of some 2,000,000° C.

At the same time, there is a good deal of other evidence in favour of the suggestion that in kathode rays we are dealing with carriers of smaller mass than atoms. One would naturally conclude that we were here dealing with what might be described as disembodied electrons, *i.e.* with electrons separated from the atoms with which they seem in general so intimately connected. Most theories of electrolysis assume that an electron can be transferred from the atom in the liquid to the plate, and almost any theory of metallic conduction must involve the transference of electricity from molecule to molecule in the conducting solid. The only difference between these cases and that of the supposition that kathode rays are torrents of electrons is as to the distance the electron can travel from molecule to molecule. If it can ever leave one molecule to join on to another, why may it not jump some centimetres of space between them? This reconciles to some extent the radiant matter and pure ether theories of the kathode rays. It makes them essentially an ether phenomenon, while at the same time they are streams of particles: it makes them light on the emission theory.

It ought to be possible to test whether these emissions are material or not, by collecting them in a small vacuum tube. It is not generally appreciated how very small a mass of gas there is in a small highly exhausted vacuum tube, though it contains enormous numbers of molecules. At the pressure of a millionth of an atmosphere, which is quite a large pressure of about a dyne per sq. cm., there could be collected in a few minutes in a tube of several cubic millimetres capacity a quantity of hydrogen which it would require 100,000 years collecting at the same rate in order to collect a gramme of it.

In every way the book is suggestive, interesting, and inspiriting, and as such should fulfil its purpose of provoking research and advancing science.

GEOMETRY OF POSITION.

Lectures on the Geometry of Position. By Theodor Reye, Professor of Mathematics in the University of Strasburg. Translated and edited by Thomas F. Holgate, M.A., Ph.D., Professor of Applied Mathematics in North-western University. Part I. Pp. xix + 248. (London: Macmillan and Co., Ltd. New York: The Macmillan Company, 1898.)

AT last there is an English edition, translated in America, of the first part of Prof. Reye's "Geometrie der Lage," of which the first edition appeared as long ago as 1866. The methods followed offer so many advantages, and the style adopted is so lucid, that we heartily welcome this translation, and we with confidence express the hope that it will awaken new interest in the study of this charming subject in this country as well as in America.

The book owes its origin to lectures delivered to engineering students at the Polytechnic School at Zürich. They were undertaken with the view of giving the students that geometrical knowledge which they required in order to listen with advantage to Culmann's lectures on graphical statics.

Culmann based his new science upon the very abstract "Geometrie der Lage" by Von Standt, and this prescribed the course which Reye had to follow. He did so willingly, and says in the preface to the first edition:—

"One principal object of geometrical study appears to me to be the exercise and the development of the power of imagination in the student, and I believe that this object is best attained in the way in which Von Standt proceeds."

The object of Reye's lectures, therefore, is not only to impart knowledge of conics and quadric surfaces, &c., but also and especially to educate the student's mind in the faculty of easily and readily realising geometrical figures in space, a faculty very important to engineers.

"Geometry of position," as opposed to "metric geometry," with which alone Euclid deals, excludes all measurement. But whilst the older authors and founders of this modern science based it on Euclidian propositions, Von Standt has shown that these can be altogether avoided, and Reye follows this course rigidly.

Here everything is based upon harmonic points in a range, and harmonic rays in a pencil, or, as the translator calls it, a sheaf.

All the previous knowledge needed consists of a clear notion of the concepts of point, line and plane, and their fundamental properties, such as the propositions that two points determine a line, two planes meet in a line, &c., together with a power of imagining these elements in their mutual relation in space; for instance, that a line may lie in a plane, or else can cut it in one point only.

These ideas being in the mind of the reader, nothing more is required, and they will themselves gradually become developed and gain in clearness as he proceeds.

It goes without saying that such a system requires a number of new concepts; namely, those of the primitive forms, "the elementary prime forms" in Leudesdorf's translation of Cremona's "Projective Geometry." These are explained in Lecture i.

In the second lecture the correlations between the prime forms as given by projections and sections are considered, and these lead to the ideal elements at an infinite distance. By their aid the exceptions due to parallelism are got rid of. At the same time a first instance is given of the leading principle of "correspondence" between the elements in two or more prime-forms.

In Lecture iii. the principle of duality appears as a natural and simple consequence of the first and fundamental properties of the elements.

After these preliminary lectures we come in the next to "harmonic forms," which are deduced by aid of certain simple constructions in three dimensions without reference to measurement. There is added a discussion of their metrical properties.

In the fifth lecture we have the projective properties of primitive forms, and the all-important principle of correspondence between the elements in two of them. It ends with the generation of curves of second order and second class, respectively, by projective ranges and sheaves (flat pencils), the actual construction of points on, or tangents to such curves being given.

With this the reader has finished the preliminary work. It may at first have appeared to him somewhat tedious, as he is unable to appreciate the usefulness and fertility of the definitions and methods explained. He has acquired many definitions and plenty of new ideas, but not as in Euclid at every step a tangible result. This is now all changed. The next chapter shows that the time and trouble expended are to be amply repaid, for now the study of the curves mentioned begins, and he is told that these curves are the conic sections. Side by side with these go the generation and the properties of cones of the second order, and cones of the second class, but these are at once dropped, as their properties are an immediate consequence of the curves. The latter are now investigated in detail. Their construction is more closely examined, and leads almost at once to the celebrated theorems of Pascal and Brianchon. It also follows that five points or tangents determine a curve of the second order or class.

The fact that these fundamental properties appear at the very beginning is characteristic of the whole method, and this shows that the method is a natural one.

In the seventh chapter the more immediate consequences of these theorems is considered. The curves are also classified as ellipses, hyperbolæ, and parabolæ, according to their elements at infinity.

In Chapter viii. the special case of Pascal's theorem when the hexagon is reduced to a quadrilateral leads to the theory of pole and polar, and these are in the next lecture specialised by aid of the lines and the points at infinity so as to give the properties of centres, diameters, and axes of conics. In this lecture, too, the equations of the conics are obtained, and thus the proof is given that the conics studied by aid of coordinate geometry are the same as those here considered.

Of course the principle of duality is constantly used, and properties of curves of second order and second class are treated simultaneously till in Lecture vii. their identity is proved. Numerous other theorems of conics are given at every stage, but we have only mentioned a few in order to show the sequence in which they follow.

Of this enough has been done, and the contents of the rest of the book can be dealt with more summarily.

Lecture x. treats of the ruled quadric surfaces; the next of projective relations of "elementary forms," viz. the range, the sheaves, curves and cones of second order, and the ruled quadric surfaces.

These relations lead to the "theory of involution," Lecture xii. The metric properties are considered in Lecture xiii., and applied to establish the *focal properties* of conics; whilst in Lecture xiv. problems of the second order are solved, and "imaginary elements" introduced in the manner of Von Standt. By their aid problems are solved by actual construction on the drawing board, in which among the given data are "imaginary" elements; for instance, the problem of drawing a conic which passes through three given points, and the two points in which a given line cuts a given conic in the case where these points have no actual existence.

It will be seen that hereby again the greatest generality is obtained, and that the exceptions which would occur it the different case where the line cuts the conic, touches it, or does not cut it, are to be treated separately.

In the fifteenth and last lecture, principal axes and planes of symmetry, focal axes, and cyclic planes of cones of the second order are dealt with.

This finishes the first part of Reye's work, which is restricted to the investigation of curves and surfaces generated by projective primitive forms of one dimension, the range of points, the sheaf of lines and the sheaf of planes, that is the range and the flat and axial pencil.

The projective and primitive forms of two dimensions give rise to quadric and cubic surfaces and twisted cubic curves, whilst the forms of three dimensions, viz. the space with points and planes as elements lead to the theory of co-linear and reciprocal spaces. These form the contents of Vol. ii. The translator does not say anything about it, but as the volume before us is marked both on the title-page and the back as Part i., there seems reason to hope that the translation of the second part will soon follow.

There is, however, an appendix to Part i., which has still to be mentioned. It contains an account of the principle of reciprocal radii, Dupin's cyclide, ruled surfaces of the third order, quadrangles and quadrilaterals, which are self-polar with respect to conic sections, and lastly a pretty full, though condensed, account of nets and webs of conic sections.

The translation is very well done. It has evidently

been a labour of love to Prof. Holgate. He has, however, in the terminology departed somewhat from that which has been used in this country. He has altogether eschewed the word "pencil"; instead of it he uses for the flat and axial pencils "sheaf of rays" and "sheaf of planes," thus appropriating the word sheaf to one-dimensional forms, whilst it has in England been used for pencils of lines and planes in space. For these he takes the word "bundle," thus adopting the German phraseology. We think it is a pity he has made this change, not because the old terminology is better, but because it makes the adoption of a uniform system more difficult.

The translator has made a few changes from the original. He has broken up the lectures into articles which he has numbered, and he has placed the numerous exercises at the end of each lecture to which they belong, instead of leaving them together at the end of the book as in the original. He has also added an index. These are decided improvements. In his preface he gives a short account of the history of projective geometry.

As far as the paper, the printing and the figures are concerned, the book ranks among the best we have seen; in these respects it is, in fact, above praise.

We recommend the book to *all* students of mathematics, and advise them not only to read it, but also to actually make accurate drawings of at least a great number of figures; especially to construct a variety of conics from given conditions, and to solve as many as possible of the problems proposed. These constructions should be made accurately on the drawing board. They offer a wonderful incitement to accuracy and neatness, as every fault in drawing becomes at once evident to the eye. For this reason the schoolmaster who has to teach mathematics and geometrical drawing on the modern or science sides of schools, will find it of great advantage in his teaching. The book will afford him innumerable examples for geometrical drawing, even if he cannot much hope to enter at present on teaching the theory; although there is no reason, as far as the difficulty of the subject is concerned, why he should not introduce a good deal in the higher forms. It is most stimulating to young students, as is evidenced by the fact that students have repeatedly told us that, although at school they could not take any real interest in Euclid, and found geometry very hard, they found the theory of conics as treated according to Reye delightfully easy and interesting. In fact, the subject is full of life; the figures grow organically one out of the other, and the Propositions arrange themselves in a natural sequence. O. HENRICI.

RACIAL ANATOMY.

Observations sur les Variations Musculaires dans les Races Humaines. Par Théophile Chudzinski. Memoires de la Société d'Anthropologie de Paris, Ser. 3; t. ii.; fasc. 2. (Paris, 1898.)

THIS posthumous work of Chudzinski is a laborious and systematic attempt to open up quite a new field of anthropological investigation. It may be said, with perfect truth, that the study of the various races of mankind has been superficial and empirical; observations hitherto have been confined to features, colour of skin, size of body, proportion of limbs and bone measurements. With the exception of the late Prof. Giacomini of Turin, Chudzinski is practically the only man that ever went beneath the skin to discover the real and essential features that separate one race of man from another. There is no desire here to minimise the value of the few briefly recorded dissections, made on dark-skinned waifs that have died in Europe, and found scattered in the anatomical literature of the present century; the observations on the brains of negroid races by Parker, Broca, Gratiolet, Waldeyer, Marshall, Tiedemann, Calori and Barkow are good so far as they go, dissections of individual specimens made by Flower and Murie, Cuvier and Turner, are efforts in a right direction, but the merit of having opened up a systematic investigation of the anatomy of the races of mankind, taking a group of individuals to represent the race, remains to Chudzinski and Giacomini. This treatise is a record of the muscles of ten negroes, five negresses, five individuals belonging to yellow-skinned races, contrasted with the muscles of six individuals of a white-skinned race.

The result of this laborious investigation is to show that, on an average, in size, in proportion of flesh and tendon, in relative and absolute extent of attachments, the muscles of Chinamen, Frenchmen and negroes are very different. Unfortunately, Chudzinski's methods are open to serious criticism. Take his account of the *soleus* muscle as an example; it is a muscle peculiarly adapted in men for erect progression. He gives in millimetres the extent of its attachment to the fibula: the extent of origin in white men is 135 m.m.; in yellow races, 97 m.m.; in negresses, 94·5 m.m.; in negroes, 120 m.m.; the extent of origin is greatest in white men, as one would expect, but it is obvious that a great error is introduced if no account is taken of the size and stature of the individuals compared, and of this factor Chudzinski has taken no cognisance. Only here and there are relative measurements given. Yet on the whole there can be no doubt that Chudzinski has, in his minute analysis of the muscular system, discovered very numerous features wherein the white, the yellow and the black man differ, and his results may be summarised by saying that, on the whole, the muscular arrangement in the white man is more accurately and powerfully adapted for erect progression of the body and precision in the use of his hands than in the negro, and in some points, although by no means in all, the muscular system is rather more simian in the negro than in the white man.

But by far the most valuable part of Chudzinski's work lies in his observations of muscular anomalies. Adding his work to Giacomini's it may be said, without any danger of over-stating the case, that the negro shows in his muscular anomalies twice or three times the number of simian characters met with amongst white men. Looking at it from the point of view of descent, the negro has retained certain primitive features much more than the white races, among them his black colour.

Little notice was taken in this country of Chudzinski's death, which took place in Paris some eighteen months ago. He was born a Pole, and, when a student at Moscow University, became involved in the insurrection of 1863, and, like many of his countrymen who afterwards became known in science, sought refuge in Paris.

He became laboratory assistant to Broca, and afterwards one of his ablest disciples. He was always extremely rich in modesty and poor in means; spent his life unostentatiously and contentedly plodding through a wilderness of dry detail to gather a handful of generalisations such as may be seen in this his last work.

OUR BOOK SHELF.

An Experimental Course of Chemistry for Agricultural Students. By T. S. Dymond. Pp. 192. (London: Edward Arnold.)

THE attempt is often made to teach agricultural science to students who have received no previous scientific training; the results of such an attempt are usually very unsatisfactory. Agricultural problems are indeed highly complex, and if the student is to understand the investigations which have been made to solve them, and is rightly to appreciate the results, he must be first acquainted with the laws and facts of nature which are involved in the phenomena under consideration. The teaching of pure science must thus always precede the teaching of applied science. Technical instruction given alone, can only consist of a series of directions and prescriptions, which are necessarily of very limited value. As soon as a scientific exposition of the subject is attempted, the preliminary study of pure science becomes essential to success.

The book before us is an introduction to chemical science, intended for students who are about to study the chemistry of agriculture. The course of instruction is intended to be given in a chemical laboratory, and the greater part of the experiments are to be performed by the students themselves; this is undoubtedly the best way of learning a science. Mr. Dymond is much to be congratulated on the very carefully constructed scheme of work which he has now published; its practical merits are doubtless to a considerable degree due to the fact, mentioned in the preface, that the scheme has been in use during the past three years in many evening schools and classes in the County of Essex; the ideas of the author have thus been gradually perfected by practice. The course is intended as an introduction both to inorganic and organic chemistry. The subjects selected for the various lessons are, when possible, of an agricultural character. Too much is sometimes attempted in this direction. Subjects such as the physical properties of soil, and the composition and properties of milk and butter, fully deserve to be treated of in several lessons, instead of the present brief notes in small type. The two pages on the chemistry of animal and vegetable life are a further example of the inadequate treatment of subjects which really lie outside the scope of the present course. Mr. Dymond would do well to write a second course of instruction, to follow that which he has now published; in this the problems of agriculture could be made the principal subjects of study. We can cordially commend the book. R. W.

Gesammelte Botanische Mittheilungen. Von S. Schwendener. Two volumes. Pp. iv + 453 and 419. (Berlin: Gebrüder Borntraeger, 1898.)

THE last few years have seen the appearance of "collected works" of more than one eminent German botanist, and all students in the science will welcome the newest addition to this form of literature.

Truth to tell, Prof. Schwendener's work has hardly met with the general recognition it deserves. Of course every one is familiar with his relation to the lichen controversy, and most of us have doubtless a more or less intimate knowledge of his work on the ascent of sap. Of his other writings, especially on physical matters many have but a very scant acquaintance, and even the anatomical papers are not as widely read as they deserve.

In a great measure this is no doubt due to the medium which Dr. Schwendener commonly selected for publication, which prevented their free circulation amongst fellow students; but now they are rendered accessible, they will assuredly command more attention at first hand. For there is an immense amount of valuable and interesting matter contained in the bulky volumes before us, even though it is not always possible to follow the author's meaning with ease, owing to his somewhat difficult style.

The papers are all accurate reprints (with the plates) of the author's works which have been published since 1879; but where his views have undergone modification since the appearance of any paper, readers will find his present opinions stated in the appendices which are added at the end of the text.

As the papers have thus appeared for some time, it is not necessary to discuss their contents here; and it may suffice to say that they deserve, and doubtless will obtain, an honoured place in every botanical library.

Die Bewegung im Weltraum. Von E. Kethwisch. Pp. 184. (Berlin: Schneider, 1896.)

THIS book contains a criticism of the theory of universal gravitation, although it does not deny that Newton explained the harmony of the universe with mathematical exactness. A statement of a few of the conclusions at which the author arrives, will probably suffice for the readers of NATURE.

According to the theory of gravitation the sun maintains the planets in their orbits; but what is the force that prevents the sun moving off into space? The theory demands some larger body which shall hold the sun, this new body demands another, and so *ad infinitum.* The theory of gravitation is thus reduced to an absurdity.

On p. 23 we learn that the number of oscillations of a pendulum is quite independent of the force of gravity. In fact, that theory demands that a heavy body shall attract another with greater force the lighter is the latter.

The attraction of Schehallien, as observed by Maskelyne, was due to magnetism; and if Cavendish had made his celebrated experiment with non-magnetic bodies, he would not have detected any attraction.

The discovery of Neptune affords no proof of the theory of gravitation. The received theory of the tide is absurd, as lunar attraction cannot possibly cause the semi-diurnal tide. The force of gravity on any planet is wholly due to its rotation, and its intensity is directly proportional to the *linear* velocity of a point on the equator.

It is probable that this work contains many other remarkable propositions; but the writer of this notice did not read to the end.

Small Accumulators. How Made and Used. Edited by Percival Marshall. Pp. 62. (London: Dawbarn and Ward, Ltd.)

THIS is the first of a series of small and popular scientific manuals for amateur electricians and students. The instructions are sufficient to enable small accumulators to be constructed by readers who have not any previous knowledge of electricity; and for readers who prefer to purchase these appliances, descriptions are given of several forms of storage battery.

Natalité et Démocratie. By A. Dumont. Pp. 230. (Paris: Schleicher Frères, 1898.)

THE six lectures printed in this volume were delivered at the Paris École d'anthropologie during the session 1896–97. They are all concerned with the subject of depopulation in France, variations of the birth-rate in different districts, and the importance of the effects upon national welfare.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

IN a recent issue of the *Journal of the Linnean Society* (Zoology, No. 172) there is a short paper by my friend Dr. St. George Mivart, in which he gives numerous cases of species of Lories peculiar to various Papuan or Pacific Islands, which differ in some details of coloration from allied species in other islands, while they are usually altogether unlike the other birds inhabiting the same island. He then argues, as Captain Hutton had done with regard to similar phenomena among the fruit pigeons of the genus Ptilopus, that these various specific markings cannot be useful, and especially that they cannot be needed as "recognition-marks," because the whole coloration of the genus is so distinct that they cannot possibly be confounded with any other birds now inhabiting the same islands. He therefore concludes that these facts "are fatal to a utilitarian explanation of the origin of all specific characters." At the same time he accepts evolution and the natural biological origin of these and all other characters. These conclusions appear to me to be wholly illogical and to be reached by omitting to take account of the fundamental idea of organic evolution itself, namely, that each species has been, somehow, developed from an allied but distinct species, living or extinct. I therefore ask leave to point out how this omission affects the problem.

It is quite clear then that each distinct species of lory or fruit pigeon now found isolated from their allies in so many of the Pacific Islands *must* (if evolution is admitted) have originated by modification from some other parent species. The modification may have occurred in another island (or continent) or in the island in which the modified species now exists; but, in either case during the process of differentiation, recognition-marks would be of vital importance by checking intercrossing, so much so that it is doubtful whether in many cases the required structural or physiological modifications could be brought about without them. I do not remember that this proposition has been seriously denied, and it is the omission to take account of it that invalidates the argument of Dr. Mivart and Captain Hutton, founded upon the existing distribution of the species in question.

Perhaps these gentlemen will reply that they hold the views of Romanes and Gulick, that the specific differences in question are the direct result of the action of changed conditions on the progeny of the individuals which first reached the islands; but this theory is a pure assumption in support of which I am not aware that any adequate facts or observations have been adduced, while such changes in *all* the individuals exposed to the influence of the new conditions is entirely opposed to the known facts of variation. Supposing, however, that the existing species originated in the islands where they now occur by modification of some two or more original immigrants, let us consider *how* the change would be effected in accordance with the known facts of variation and natural selection.

The first thing that happens on the introduction of a new form into an island well-suited to it, and with no other enemies than those to which it is already adapted, is to increase rapidly till the island is fully stocked—witness the rabbit in Australia, New Zealand, and Porto Santo, the sparrow in America, and numerous other cases. But as soon as the island is fully stocked and all future increase dies off annually, natural selection begins its work, and the least adapted to survive, in every stage from the egg to the parent birds, get destroyed by some means or other. Now, if this process of elimination is identical in character with that to which the species was subjected in its former home no specific change will take place, because the whole structure and habits which constituted "adaptation to conditions" in its former habitat are equally effective in its new abode. But if there is any difference in the environment which requires a new adaptation, whether as regards food, seasons, diseases, or enemies of other kinds, then natural selection will certainly tend to bring about that new adaptation, and as in such a limited area local segregation will be ineffective, some external indication, marking off the new and better adapted from the old less adapted type, will be of the first importance in the prevention of inter-crossing and thus hastening the process of complete adaptation; and these external indications are what I have termed "recognition-marks." When the new type is fully established and the old parent-form has died out, the work of these recognition-marks will have been done; but having been established by a severe process of selection they have become fixed and continue to form the "specific character" distinguishing the new from the old species. The repeated statement of Dr. Mivart, that in this or that case the peculiar marking cannot be a recognition-mark, or that such "recognition-marks" are quite needless, is therefore beside the question, since the very existence of the new species during the process of differentiation may have depended upon them.

I have here confined myself strictly to the one point raised by Dr. Mivart and Captain Hutton, having already dealt with the general question of "utility" elsewhere.

ALFRED R. WALLACE.

The Duke of Argyll and Mr. Herbert Spencer.

IN his review of the Duke of Argyll's "Organic Evolution Cross-examined, &c.," Prof. Meldola describes the Duke as "doing violence to Huxley's teaching," and asks him "in fairness" to "reperuse" something Huxley has written. After recognising the unfairness he refers to, he might not unfitly have suspected unfairness in the Duke of Argyll's representations of my views: especially considering the absurdities ascribed to me. Yet Prof. Meldola says that the Duke "makes some good points out of Mr. Spencer's change of view with respect to the efficiency of natural selection," and represents him as making merry "over Mr. Spencer's abandonment of that excellent child of his creation, the term 'survival of the fittest.'"

Had Prof. Meldola looked into the matter, he would have found that I have in no degree whatever abandoned the term "survival of the fittest." The Duke of Argyll has misrepresented me in a way which is extremely surprising. In the "Factors of Organic Evolution" ("Essays," i. 429-30), after pointing out that the metaphorical character of Mr. Darwin's expression "Natural Selection" is apt to mislead, as he himself admitted, I said that "kindred objections may be urged against the expression 'survival of the fittest.'" I said that "survival" "suggests the human view of certain sets of phenomena" rather than the view of them as physical facts; and I further said that "If a key fits a lock, or a glove a hand, the relation of the things to one another is presentable to the perceptions. No approach to fitness of this kind is made by an organism which continues to live under certain conditions" (p. 430). But there is no admission that the words, imperfectly adapted as they are, fail to express the truth in question with approximate correctness. Any one who will turn to the chapter on "Indirect Equilibration," in vol. i. of the "Principles of Biology" (§ 164), will read as follows:—

"That is to say, it cannot but happen that those individuals whose functions are most out of equilibrium with the modified aggregate of external forces, will be those to die; and that those will survive whose functions happen to be most nearly in equilibrium with the modified aggregate of external forces. But this survival of the fittest implies multiplication of the fittest, &c."

It was in this place and in this manner that the expression "survival of the fittest" arose, and to show that I have abandoned the belief it formulates it is needful to show that I have abandoned the theory of indirect equilibration which it is used to express briefly. I have done nothing of the kind, and there is no sign that I have done anything of the kind.

I am, indeed, not a little astonished that the Duke of Argyll should have reproduced these statements of his after the direct contradiction given to them in my reply to him published in the *Nineteenth Century* for February 1888. At the close of my article, entitled "A Counter Criticism," there occur the sentences:—

"On one further point only will I say a word, and this chiefly because, if I pass it by, a mistaken impression of a serious kind may be diffused. The Duke of Argyll represents me as 'giving up' the 'famous phrase,' 'survival of the fittest,' and wishing 'to abandon it.' He does this because I have pointed out that its words have connotations against which we must be on our guard, if we would avoid certain distortions of thought. With equal propriety he might say that an astronomer abandons the statement that the planets move in elliptic orbits, because he warns his readers that in the heavens there exist no such

things as orbits, but that the planets sweep on through a pathless void, in directions perpetually changed by gravitation."

It remains to remove a misapprehension of Prof. Meldola's own. He says: "It may be well to indicate that many—perhaps we may say the majority of biologists in this country—have long ago parted company from Mr. Spencer on this question of the enhanced importance of 'direct equilibration,' and the subordinate position assigned to 'indirect equilibration' in his later writings." I know of no foundation for such part of this statement as refers to my opinions. That I have not changed my view concerning the respective shares of direct and indirect equilibration there is incontestable proof. If Prof. Meldola will turn to § 170 (p. 468) of the "Principles of Biology," first edition, he will find it there contended that at first "natural selection worked almost alone in moulding and re-moulding organisms into fitness for their changing environments; and natural selection has remained almost the sole agency by which plants and inferior orders of animals have been modified and developed." He will find it further said that in proportion as organisms become complex and active, "the production of adaptations by direct equilibration takes the first place—indirect equilibration serving to facilitate it." And now, if he will turn to the revised edition of the "Principles of Biology" issued last year, he will find that the two sentences quoted stand as they did in 1864.

Prof. Meldola has been misled by a not unnatural illusion. I have of late years had occasion frequently to insist on the share taken in organic evolution by direct equilibration (or the inheritance of functionally-produced changes) because it has been continually denied; and frequent insistence on its share has been mistaken for an alleged extension of its share.

Brighton, January 8. HERBERT SPENCER.

Carte Géologique internationale de l'Europe.

I HAVE just received, through Mr. Edward Stanford, Livraison iii., containing seven sheets of this great work, in which we have the maps of the British Isles, of Germany, Italy, Austro-Hungary and Greece. These maps exhibit a marvellous amount of care on the part of the Directors, and of elaborate execution on the part of Herr Dietrich Reimer and his staff. I do not venture to eulogise, much less to criticise the maps, but only to direct attention to one special point of interest which they exhibit, namely, the representation of the great terminal moraines on both sides of the Alps. It requires a little close scrutiny to discover the course of these great banks of glacier detritus laid down at the epoch of greatest cold of the Glacial Period; but once recognised, it amply repays attention to follow their course. They are represented by lines of purple dots, about three or four deep, lessening in size inwards; and, of course, passing disconnectedly over all the geological formations. On the north base of the Alps the moraine bank starts from above Grenoble, swelling northwards near to Lyon along the Rhône valley; then, retreating southwards, it winds along the flanks of the Jura above the plain of Geneva and Lake Neuchâtel; then passing by Berne and Zürich, stretches away northwards by Schaffhausen and Ravensburg, indicating the enormous extent of the old Rhein Glacier; and then curving outwards along the valleys descending from the eastern Alps by Munich and Salzburg, it is represented as surrounding the northern shore of the Traun See; but no further eastwards.

The northern limit of erratic blocks is represented by a nearly continuous red line extending generally much further from the base of the Alps than is the case with the terminal moraines. Commencing on the west at Grenoble the line curves round by Lyon and Bourg, and then ranging along the Jura Meridional, celebrated for the huge boulders of granite which are there stranded, stretches northwards towards Besançon; thence, skirting the Rhein valley near Basel, the line stretches eastward by Schaffhausen, where it almost skirts the northern base of the moraine, and so passes onwards by Munich to the banks of the Enns by Steyr (Steyer).

The great glaciers which descended from the Alps on the Italian side have (as is well known) left behind them huge moraines, which are also represented in a manner similar to those on the north side. Thus we have the great terminal moraines of the rivers Dorea Riparia and Dorea Baltea near Turin; then, further eastward, those which border the southern shores of Lakes Maggiore, Como, D'Iseq and Garda. The southern limit of erratics is only represented at a few places, and then generally in close proximity to the margin of the moraines. The close connection of the great Italian lakes with the moraines cannot be overlooked by those who recognise the evidence adduced by the late Sir A. C. Ramsay in support of his views on the glacial origin of lakes. The moraines of the Dorea Riparia and Dorea Baltea were amongst his favourite illustrations.

Before closing I might be allowed to add that the topography of the map is admirable, while the coloration of the geological formations, except, perhaps, in the case of the British Isles, fully sustains the reputation of the Lithographic Institute of Berlin. EDWARD HULL.

January 3.

Periodic Tides.

CAPT. A. S. THOMSON (p. 125) calls attention in your columns to the subject of short period oscillation of water-level at Malta and Sydney, and asks for further information from others. As I have given some attention to studying similar phenomena on the eastern coast of Canada, I venture to offer the following additional information and suggestion of an explanation.

(1) The phenomena are very common. At St. John, New Brunswick, on the coast of the Bay of Fundy, the oscillations have a fairly constant period of 43 minutes. At Quaco, a few miles further up the bay, the period is only $12\frac{1}{2}$ minutes. At Halifax, Nova Scotia, on the Atlantic coast, the period is $23\frac{1}{2}$ minutes. In the Gulf of St. Lawrence, at South-West Point (Anticosti), the oscillations are rapid but irregular; at St. Paul's Island, very rapid and irregular; at Forteau Bay, small and irregular; at Carleton (Quebec) there is some indication of a 22-minute period; at Souris (Prince Edward Island) the oscillations are rapid and irregular; at Pictou (Nova Scotia), small and irregular: at St. Peter's Island, very rapid and irregular.

(2) Any explanation must account for two distinct things: the *origin* of the fluctuations, and their *periodicity*. Let us take these in reverse order.

(3) The period of the oscillations (where they have a definite period) is, I believe, simply the period of the free natural vibrations of a semi-confined body of water "wish-washing" to and fro like water in a wash-bowl, the oscillations being sometimes *fundamental*—that is, consisting in the vibration of the body of water as a whole; and in other cases (perhaps the majority of cases) *partial*—that is, due to the body of water dividing up into two vibrating halves, or three-thirds, &c. In a very irregular basin, like the Gulf of St. Lawrence, regular vibrations are impossible. In some other cases the basin is of sufficiently regular form to admit of fairly regular oscillations, but not regular enough for the period to be deduced mathematically. In only two cases have I found a mathematical test possible. At St. John, the Bay of Fundy is bounded on one side by the slightly indented New Brunswick coast, and on the other side by the straight, abrupt Nova Scotia coast, these two shores being only slightly inclined to one another. The width may be taken as forty miles, and a study of the chart gives the mean depth *at low tide* as 34·4 fathoms. The period of fundamental vibrations across such a basin is given (to a sufficient approximation) by

$$t = \frac{2l}{\sqrt{gh}},$$

l being the width, and h the mean depth. With the above figures, this gives for fundamental vibrations a period of 87 minutes, and for first partial vibrations a period of 43·5 minutes. The latter is remarkably close to the observed period of 43 minutes. It should be noted that the calculation applies to low tide. Now, the tide at St. John has a range of 20 feet, while the formula shows that the period varies inversely as the square root of the mean depth. A simple calculation shows that the period at high tide should be two minutes less. From an examination of all the cases available, I found that the mean period for high tide was actually 1·6 minutes shorter than for low tide; but the fewness of the well-marked cases available to me for making this test (thirteen in all) makes me believe that this agreement is somewhat accidental.

The other case known to me to which a similar calculation can be applied, is that of a small basin in the St. John River, just before it flows through a very narrow gorge into the harbour. While using a rough form of self-recording tide gauge for finding accurately the time of high water, I discovered on the

record, not only the above-mentioned 43-minute oscillations, but also a series of much more rapid oscillations having a period of about 35 seconds (the latter figure being obtained by a stop-watch). The width of the basin is, at the point of observation, 2030 feet, and its mean depth about 100 feet (the tidal range is less than 2 feet). Calculation by the above formula gives, for first partial vibrations, a period of 35·8 seconds, which is very close to the 35 seconds observed; but it is to be noted that for a basin whose depth is *not* small compared with its width, the above formula is somewhat in error, and a more correct formula (involving a hyperbolical cotangent) gives 37·5 seconds. In any case the agreement is striking, and the two instances given are almost conclusive as to the explanation advanced. Simultaneous observations on opposite sides of such a basin would be quite conclusive, but these I have not yet had an opportunity to make.

(4) The following notes on the other cases referred to in (1) may be of interest in connection with observations referred to by Capt. Thomson. Quaco is only about twenty miles further up the Bay of Fundy than St. John, and yet, while expecting to find there a period similar to that at St. John, I found a period of 12½ minutes (from four separate records). This was at first puzzling, but, later, an examination of the chart showed the existence of a dangerous ledge (the Quaco Ledges) coming nearly to the surface, at a distance of eight or ten miles off shore, and forming, with a headland above Quaco and another below, an irregular basin, the dimensions of which no doubt determine the period of oscillation. A quite similar explanation applies to the oscillations at Halifax, for there a succession of banks (the Emerald, Sable Island, Le Have and Roseway) form, with the Nova Scotia coast, a large-sized bay of irregular shape.

(5) As to the external impulse that starts the oscillations, there is much uncertainty. Marked oscillations at St. John are frequently accompanied by barometric disturbances, but not always. My own observations make me believe that the oscillations and heavy ground-swell usually coexist. A notable case (for which I have to thank Mr. S. W. Kain, of St. John) occurred on September 18, 1898, when the heaviest ground-swell in several months was accompanied by marked periodic oscillations recorded on the Kelvin gauge. On the whole, I believe that the disturbance of equilibrium is due either to abrupt local variations of atmospheric pressure, or to the transmitted effect of a distant hurricane.

Those who are interested in this subject will find fuller details of the cases here discussed numerically (and also a short bibliography of the subject) in a paper by myself in the *American Journal of Science* (vol. iii., 1897). The nature of the oscillations in the Gulf of St. Lawrence are shown on curves that illustrate a tidal report, by Mr. W. Bell Dawson, in the last volume of *Transactions* of the Royal Society of Canada (see NATURE, vol. lviii. p. 260).

A. WILMER DUFF.

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GENERAL LAW OF THE PHENOMENA OF MAGNETIC PERTURBATIONS OF SPECTRAL LINES.

IN the *Philosophical Magazine* for April 1898, I pointed out that the resolution into triplets, &c., which the spectral lines suffer in a strong magnetic field, did not appear to follow any obvious general law, but appeared to be some complex function of the wave-length. To this was added the following remark:—"It is possible, however, that the lines of any one substance may be thrown into groups for each of which $\delta\lambda$ varies as λ^2, and each of these groups might be produced by the motion of a single ion. The number of such groups in a given spectrum would then determine the number of different kinds of ions in the atom or molecule.

"Homologous relations may also exist between the groups in different spectra, but all this still remains for complete investigation."

Although this investigation is still far from complete, yet the measurements so far made uniformly go to show that the foregoing expectation is about to prove true, and that e/m or $\delta\lambda/\lambda^2$ is the same for the corresponding lines of the natural groups in the same spectrum, and, further, that this quantity remains the same for corresponding lines or groups in the homologous spectra of different substances.

Not only is the magnitude of the magnetic effect governed by the foregoing law, but the *character* also of the effect is the same for the corresponding lines; and this is very interesting, as it shows that the corresponding lines probably arise from the same origin. The theory is consequently verified by the facts when the spectral lines are considered in groups corresponding to the molecular events which produce them.

THOMAS PRESTON.

COAST-TELEGRAPHS AND SPACE-TELEGRAPHY.

THE year 1898 was an important period in the history of space-telegraphy, it was the period in which the possibility of being able to signal across wide stretches of open sea, with certainty in all weathers and at high speeds, became first generally recognised as practicable. Within the year the final report of the Royal Commission on the question of Coast-Telegraphs, published late in 1897, came into our hands; and the last few months of the year witnessed a truce to the war of "wireless-telegraphy." A wave of good feeling has now united the opponents into something like coherence, and the honours have been divided with universal approval. The result is that for the future Italy takes prominence, England eminence, while Russia, Germany and France share the luxury of many grievances.

The close of the year is very appropriately characterised by three papers, respectively communicated by Dr. Lodge,[1] Mr. W. H. Preece,[2] and Mr. S. Evershed,[3] to the Institution of Electrical Engineers, all emphasising the merits of one and the same system of space-telegraphy. The authors themselves were more or less unanimous as to the course further experiment should take, but the discusssion that followed the reading of these papers showed a certain lack of directness; many of the speakers were carried away by side issues, and a great deal of time was occupied with ill-considered suggestions and old matter. While fully recognising the value of open discussion, and of hints thrown out at random on subsidiary matters, the present writer thinks it may be useful here to indicate the limits to which the problem may be narrowed down, and to point out the very serious work that is now calling for the aid of space-telegraphy.

It is very generally admitted that space-telegraphy will replace metallic-circuit systems only under conditions where metallic circuits are impracticable. The fact that metallic circuits have been laid over the Andes, may be taken as proof that there are remarkably few land-areas that cannot be spanned by wires. For communication between *fixed* points on rough coasts, a wire suitably protected is still the right and the best thing, as is evidenced by the cable[4] laid in 1890 between Pollagill Bay on the north-west coast of Ireland, and Portdown Bay, Tory Island, and thence by duplicate underground cables to the lighthouse on the north side of the island. The great advantage of a metallic-circuit system is the consequent privacy of the messages, the simplicity of the apparatus, the speed of transmission, and the possibility the system offers for working by telephone, and in other ways avoiding the expense of skilled operators. Space-telegraphy is at present limited to comparatively short distances, and its usefulness is confined to spanning estuaries, skirting sea-boards, and for such purposes as

[1] "Improvements in Magnetic Space-Telegraphy."
[2] "Ætheric Telegraphy."
[3] "Telegraphy by Magnetic Induction."
[4] See an important paper by Mr. H. Benest, "Coast-Telegraph Communication," read before the Balloon Society, March 18, 1892).

that to which it was applied by Mr. Preece between Oban and Mull in 1895. But, except in rare instances, it is only likely to replace submarine cables between moored vessels and the shore, *e.g.* between light-ships and the coast-guard stations. The point of failure in submarine-cable communication thus happens to coincide with the point of favour of space-telegraphy. The present object of those working at space-telegraphy should therefore be to supplement the cable-system of coast telegraphs, so that all the light-vessels and lighthouses of our coasts may be brought into communication with one another and with the life-boat stations.

Some idea of the scope of the work of completing our coast-telegraphs may be gathered from the fact [1] that the whole number of distinctive lights, including port, harbour, and pier lights, light-vessels, and lighthouses on the coasts of the United Kingdom in October 1898 was 1095, and at the beginning of that year only[2] 51 light-vessels and light-ships were in communication with the telegraphic system. Three additional lighthouses, *i.e.* those at Godrevy, the Skerries, and Walney Island, were connected to the shore during last summer; but pending [3] further results of the experiments with the system of "wireless-telegraphy," it was thought better to postpone the work of connecting more light-ships to the shore by electric cables. These lighthouses and other sea-marks are maintained out of the fund [4] derived from lighthouse tolls, which amount to over 500,000*l.*, the lighthouses, &c., being thus self-supporting. This fund has lately been augmented by a special grant; with a view to increasing the efficiency of the system.

The hard task of establishing communication with a light-ship moored in a tide-way, successively rising and falling at each tide, swinging, rolling, and pitching, and in other ways gesticulating around her uncertain anchorage, has taxed the resources of cable engineers for the last quarter of a century. The system now generally adopted consists in the use of a swivel[5] or toggle having a hollow spindle so as to allow a telegraph-cable to be passed up through the middle of it. This swivel is placed between the ship and her moorings at about the water-line. One or more chains lead down from "eyes" on the swivel to the mooring anchors; there are generally two such chains, or there may be three, spread out tripod-fashion, to terminate in mushroom anchors. A riding-chain leads upwards from the swivel, and is secured to the vessel in the ordinary manner after passing through the hawse-pipe; the cable is hauled on board through the hollow swivel, over a sheave and on to a drum, which can be turned round by hand as required, to take the twists or "turns" out of the cable as they are formed. A special veering-drum has been designed by Mr. Benest,[6] by means of which this operation of taking out "turns" is performed automatically by a special gear on the drum. Electrical communication is maintained through the axes of the drum by brush-contacts or otherwise. In rough weather the riding-chain is generally veered out, sometimes up to fifty or sixty fathoms; and after a gale it is often found in tangled masses, which are sometimes as large in girth as that of a man. The cable itself, if it has not been entangled, has meanwhile been saved from kinking by the swivel device, but it suffers a good deal from the threshing and flattening against the bottom, from friction at the swivel, and occasionally from fouling the chains. An ingenious type of veering-cable has been designed by Mr. F. C. Crawford,[7] which is built up in such a way that it is very difficult to make a kink in it. To secure this result, the stranded conductor of seven tinned copper wires is covered with india-rubber and lapped with cotton tape to make a bedding for the sheathing wires. The sheathing consists of twelve double-tinned steel wires, each coated separately with india-rubber and tape. Finally there is an outer serving of india-rubber, which encloses everything into a compact form, and, while allowing the requisite amount of flexibility,[1] prevents the sheathing wires from slipping over one another when the cable is bent. As a further protection, especially against the "threshing" action, this veering-cable is occasionally threaded with beads or ferrules of lignum vitæ, or with washers of india-rubber.

Another metallic-circuit method has been tried at Sandy Hook,[2] in which use is made of the mooring chains themselves as a means of connecting a telephone in circuit from the vessel to the cable. This method is reported upon very favourably by its designers, Messrs. Blake and Caldwell, but in their account of it the conditions are not very fully elaborated. The present writer made some experiments in this direction some years ago, and came to the conclusion that the conductivity of such chains was too variable to be trusted. His tests showed that a mooring-chain of 2-inch links and ½-inch iron, 12 fathoms in length, after being pickled in tar, dried, and slung up in the air, had a resistance of 9 megohms when tested with 100 volts; when tested with 750 volts the resistance broke down to 400 ohms. A similar chain, dry and somewhat rusty, had a resistance of 850 meghoms. When dipped in water and again slung up, the resistance of the 12 fathoms was 25,000 ohms. Chains sagging in water were able to transmit telephone currents with a battery of a few volts. Two mooring-chains, of the same dimensions as those described above, were carefully tarred, and the contacts at the links were cleaned bright over a small area. The chains were then paid out from the shore parallel to one another, 8 feet apart, in about 2 fathoms of water in the Thames, the distant ends being hauled on to a barge. Telephoning between the barge and the shore was impossible, even with 100 volts in the circuit. All the electricity passed from chain to chain by way of the water. Brass chains had, of course, much lower resistance than the iron chains; the resistance of brass chains was practically the same, wet or dry. But it was always found that with any chain whatever in the circuit, the loose contacts caused "buzzing"[3] in the telephone. It is possible that Messrs. Blake and Caldwell used chains under great stress, or that they used some special device, but in view of his own experiments the present writer does not regard the chain system as a practicable one.

Some years ago an alternative method of connecting a light-ship to a telegraph cable was suggested by Mr. James Wimshurst. He arranged a swivel which contained two flat coils, a primary and a secondary, placed one over the other, so that one could rotate coaxially upon the other, for the purpose of avoiding kinks as the ship swings about. As a matter of fact, the danger does not depend so much upon the twist, as upon the threshing action due to the rise and fall of the cable. Mr. Wimshurst's suggestion is worthy of a trial, but it must be remembered that the swivel, in the form proposed by its designer, meets only a very small part of the difficulty.

This short review of metallic-circuit and allied direct-cable methods, serves to show that the attempts made in this regard by the Royal Commission have only resulted in partial success.[4] While admitting that the problem is now fair game for the space-telegraphers, the present

1 *Liverpool Mercury*, October 26, 1898.
2 Report of the Royal Commission, September 1897.
3 *Times* House of Commons Report, July 1, 1898.
4 *Imperial Institute Journal*, March 1896.
5 See Bedwell's Patent, No. 367, 1876.
6 Patent, No. 19,646, 1895.
7 Patent, No. 21,657, 1895.

1 This cable is in use at Formby Light-ship, with very satisfactory results.
2 Annual Report of the Lighthouse Board of the United States, June 30, 1895.
3 See *Electrical Review*, vol. xxvii. p. 57 and p. 656, 1890; also May 14, 1897.
4 *Standard*, Friday, February 1, 1895: "The Ramsgate life-boat and tug *Bradford* proceeded to the Goodwins, in response to signals of distress from the lightship; the lightship telephone having, it is understood, got out of order."

writer would point out that the resources of cable engineers in devising direct metallic-circuits are by no means exhausted. There is a singular lack of evidence on this point in the Blue Books; the Royal Commission seems to have swung about a good deal on its own small swivel, with something very like disregard for outsiders. For some reason, perhaps unknown, they failed to call as witnesses the very men whose experience would have made for success. In departing from these older methods, it must not be forgotten that we are departing from all the advantages offered by the telephone; skilled operators will have to be requisitioned, and there will be need for a delicate device for "calling-up" the operator.

The fourth Report (dated May 12, 1896) of the Royal Commission concluded with a very hopeful note on a contemplated trial of an "inductive method" suggested by Mr. Evershed. "Under this system," it says, "the cable running from the shore is laid in a circle on the bottom of the sea immediately under the light-vessel, the circle having such an area that the vessel will always be within the circumference of it. Round the deck of the vessel a number of 'turns' of insulated wire are coiled, which are in connection with a telephonic receiver on board ship. This system has not yet (May 1896) been subjected to a practical test at a light-ship."

The fifth and final Report of that same Royal Commission (September 1897), referring to the trial, observes that "the experiment was carried out in August 1896 at the Goodwin (North Sand Head) light-vessel, but after a careful trial it proved a failure. The apparatus had been tested on shore with satisfactory results, but when it was tried at the light-vessel, which is moored in ten fathoms of water, it was found almost impossible to effect communication by means of it, the electric energy being almost entirely lost in the sea. The difficulties experienced were entirely electrical."

In the following year a mathematical investigation as to the cause of this failure was undertaken by Mr. C. S. Whitehead (*Proc. Phys. Soc.*, vol. xv. pt. xi. pp. 188-200, 1897); it was communicated to the Physical Society in a paper read June 11, 1897. His theoretical results show that if his calculations are correct, the normal magnetic induction of the primary coil loses 79 per cent. of its initial value in passing to the secondary through ten fathoms of sea-water. These figures as to the absorption-factor of sea-water have been criticised by Mr. Oliver Heaviside and by Dr. Oliver Lodge. In the meantime Mr. Evershed has turned his attention to improving his apparatus. In his recent paper he regards the inductive coils as a particular case of a dynamo-electric machine, he neglects the absorption-factor, and gives an expression for the power available at the receiving station for ultimate conversion into motion at the receiving instrument. The result arrived at is that the mechanical power is independent of the number of turns into which the total volumes of copper are divided on the primary and secondary circuits, and that the two circuits should have equal volumes of copper. His assumption at the outset, that the use of two horizontal circuits implies a loss of one-half the mutual induction between them, may have to be modified. Perhaps the most important part of Mr. Evershed's paper is his description of a "call" or receiving apparatus, which enables exceedingly minute currents to be detected. From a remark in his paper, he does not appear to be aware of the work that has been done in America by Lucien Blake and Eugene Caldwell in their attempts to provide an instrument to replace the telephone. In the Annual Report of the Lighthouse Board of the United States (June 30, 1895, p. 37) will be found an account of a calling device. This Report says: "The receiving apparatus or relay for this system would be vibratory in character and tuned to a frequency of vibration to correspond with the period of the calling current. In addition to this mechanical adjustment, the electrical circuits might be adapted by the use of condensers and inductances to respond more readily to alternate currents of the same period. The action of such a system would be cumulative, *i.e.* each successive impulse of current would arrive just in time to increase the vibration in the relay until sufficient amplitude would be obtained to operate a circuit-closing device." This report also touches upon an interesting point raised by Sir Henry Mance in the recent discussion. With regard to the sensitiveness of "calls," it observes that "a careful study of all kinds of instruments in which weak alternating currents produce mechanical movement, shows that by far the most efficient are those in which the current does not produce an alternating magnetic field, as in the electrodynamometer, but operates to increase and decrease the strength of field of a permanent magnet. The mechanical motion produced by such polarised machines is always vibratory. Careful measurements in the laboratory show that this relay will work positively with a current representing 0·0001 watt, and that it can be operated with much less energy than this." This report seems to have escaped the attention of Mr. Evershed; he suggested in his recent paper that so far as he was aware the ordinary Bell telephone has been exclusively used as the receiving device in this class of experiments. There is, of course, no question as to priority; Mr. Evershed was using a vibratory indicator on this synchronous principle in 1892, the American report refers to an instrument designed in 1895. In his latest (1896) form of apparatus, Mr. Evershed duplicates the vibratory metallic rectangles; they are connected to two separate secondary circuits in such a direction that they oscillate in opposite phases in a strong magnetic field. This arrangement has the advantage that when the twin rectangles are in unison it is almost impossible to bring them into contact by shaking the instrument.

Mr. Preece's paper is a history of the experiments made by himself and his staff, since 1885, on "the electromagnetic form of ætheric telegraphy," *i.e.*, on the method of signalling between one alternate current circuit and another. This work has been more or less familiarised to us by the newspapers. He used horizontal coils of large diameter at the sending and receiving stations, but they were regarded as "impractical things" and they were replaced by straight conductors, placed in parallel planes, one at each station. Capacity and self-induction were eliminated. An interesting series of experiments is described, in which two earth-plates are buried at a distance apart in the earth; the lines of electric "flow" are traced, and the locus of a hypothetical resultant-conductor is plotted. Incidentally, Mr. Preece makes the curious statement that "we know *by Ohm's law* that the resistance of a circuit increases with its specific resistance and length, and diminishes with its sectional area." By Boyle's law this involves a misconception! Of the various arrangements of inductors for his mode of signalling, Mr. Preece prefers parallel wires connected to earth at each extremity, the wires being carried to a considerable height. The most satisfactory results were obtained over a distance of 3·3 miles across the Bristol Channel; and when it is remembered that the speed of signalling is practically as high, and that the system is as certain and as efficient as the ordinary metallic circuit system, this result must be regarded as the best so far brought to notice.

The question naturally occurs to us at this point, What then has become of the "coherer" systems? Mr. Preece[1] has recently said that the Marconi system is able to traverse a distance of twenty-five miles; but on the same occasion he mentions that there would be no difficulty in communicating by the alternate-current inductor system over a similar distance. Hence there

[1] *The Engineer*, November 25, 1898.

is little to choose on the merit of distance. On the other hand the speed of signalling by the "Marconi" system is limited to something like twelve words a minute, and we must conclude that it is this circumstance that handicaps the method. It is also probable that "coherer" systems are at present too susceptible to mechanical and fortuitous electrical tremors for the ordeal of a telegraph office, but in the absence of evidence it is perhaps scarcely fair to draw comparisons in this regard. According to the *Times* of Monday, the 9th inst., arrangements are being made under the direction of Signor Marconi at the South Foreland lighthouse, and aboard the South Goodwin light-ship, for a series of experiments with his apparatus. It is stated that if the system is found satisfactory it will forthwith be adopted between those points —the distance between them is about three miles.

Two articles in the *Electrician* of November 12, 1897, one by Dr. Lodge[1] and the other by Mr. A. C. Brown, should be referred to as indicating the extent of the work done and the hopefulness of the votaries of "coherer" systems at that time. Later developments of the "coherer" system, particularly in the matter of syntony and the best arrangement of contacts, are dealt with by Dr. Lodge in a communication to the Physical Society of January 21, 1898, an account of which appeared in NATURE in February 1898. The possibility of individualising signals by syntony on Dr. Lodge's system is discussed in an excellent article in the *Electrical Review* of August 19, 1898, which is prefaced by some remarks that already show the weak points of "coherer" systems. Messages had then been sent by Marconi over a distance of about sixteen miles, and received in "dot and dash" on the Morse ribbon at a rate of something under twelve words a minute; but it had been found in practice that the principle of resonance could not be applied with sufficient effect to ensure that messages should be recorded only by a single selected receiver. Whether the later more elaborate methods of syntony for "coherer" systems, proposed by Dr. Lodge, have justified themselves in practice is not yet known, but it is a significant fact that Dr. Lodge's most recent paper on the subject of space-telegraphy makes a distinct departure from the "coherer" system, and contains no account of experiments in the direction of syntonised receivers used in this particular way.

In 1898, experiments as to the mysterious connection between "coherers" and photo-electric phenomena made little progress towards a practical system of telegraphy. In the hands of Prof. Minchin these experiments, at the outset, showed great promise; they gave us the "collecting wire" which, protruding into space, acts as a "feeler" for Hertz waves, but at present they remain as toys of the laboratory. The so-called "Lichtelektrische Telegraphie" of Prof. Zickler, of which a very good account is given in the *Elektrotechnische Rundshau*, No. 21, pp. 232–233, 1898, is more pretentious as a means of signalling. Prof. Zickler makes use of an old discovery, due to Hertz, that ultra-violet light is able to reduce the spark-resisting power of an air-gap. He directs a beam of light from an arc lamp, provided with a shutter, upon the extended spark-gap of an induction coil, and by opening and closing the shutter causes sparks to pass at the gap at corresponding intervals of time. These sparks affect a "coherer" circuit, and signalling is rendered possible. Such experiments are very attractive from a purely scientific standpoint, but it is not easy to see the advantage of this method as compared to the ordinary heliograph. Using the simplest form of apparatus, Prof. Zickler succeeded in signalling by this means across a space of two metres; and by the aid of an arc lamp that expended nearly two horse-power, and by the use of quartz lenses, that distance was extended to 200 metres. The speed of receiving the signals is not mentioned; the extreme limit is probably about twelve words a minute. He proposes to apply the system to lighthouses and to fortresses. We admit that such a system would be admirably suited for the purpose of warning our *foes* off dangerous parts of the British coasts; but for the purpose of warning our own or friendly ships, a surer means of communication must be adopted.

Comparing the various methods,[1] and keeping in mind that we are here concerned with a practical question for engineers, rather than with the scientific aspect of space-telegraphy, it would seem that the "coherer" systems as a whole are about to be cast aside, and that preference is to be given to alternate-current inductor systems for coast-telegraphs. If this is indeed to be the case, the problem is greatly simplified, and experiment resolves itself into the single task of finding the best design of apparatus for communicating between a moored light-ship and the shore by means of inductor coils. Dr. Lodge's paper on "Improvements in Magnetic Space Telegraphy" gives us what may be regarded as the academical aspect of that task; he describes a new receiving device for magnetic induction telegraphy, and he explains the method of putting it into practice. The principal feature of this device is the outcome of an electric resonance experiment first described in NATURE, vol. xli. p. 368, eight years ago—namely, the experiment of syntonic Leyden jars. Dr. Lodge now replaces the jars by condensers, and the "tuned circuits" take the form of horizontal coils of wire. The inducing coil is connected to an alternate-current dynamo, and the induced coil is connected to a train of telephone relays, the last of which is thus set into violent action at each received impulse. The paper includes the theory of two such circuits arranged in mutual syntony, and it is full of information and suggestions as to the proper course future experiment should take; the advantage of syntony is discussed, and the relative importance of conduction and induction is considered together with a detailed investigation of the theory of "detectors" for such a system.

The absorption-factor in the case of sea-water will probably be one of the first matters to be dealt with by experiment and theory in the present year. By the use of horizontal inductor coils, one on the light-ship and one ashore, Dr. Lodge avoids the practical difficulty; nevertheless the problem is sure to elicit his interest. Mr. Whitehead, holding tacitly to Maxwell's equations, deduces a law for the absorption-factor, and to this law Dr. Lodge takes exception. Maxwell supposed that the total current was made up of the polarisation current and the induction current; Mr. Whitehead assumes that the polarisation current may be neglected, and that provided the frequency is not comparable with that of light, no serious error can arise from that assumption. Do Maxwell's equations fail then for such a case? Dr. Lodge seemed unwilling to admit that they do fail; he suggested that Mr. Whitehead had written them down in a form that did not agree with Maxwell, and that Prof. J. J. Thomson had written them in yet another form. Mr. Whitehead now asks Dr. Lodge what is the right form? And that's how the matter stands.

ROLLO APPLEYARD.

[1] By a slight error, Dr. Lodge there attributes an experiment on liquid "coherers" to Lord Rayleigh. This experiment was first described and shown by the present writer on March 26, 1897, at the Physical Society. A few weeks later it was *repeated* by Lord Rayleigh at the Royal Institution.

[1] For the various methods of space-telegraphy, see a paper by Dr. S. P. Thompson (*Soc. Arts Journal*, 46, pp. 453–460, 1898).

THE FISHES OF TANGANYIKA AND OTHER GREAT LAKES.

THE first part of the fifteenth volume of the *Transactions* of the Zoological Society of London, which has just been issued, is devoted to a report by Mr. G. A. Boulenger, F.R.S., on the collection of fishes made by

Mr. J. E. S. Moore in Lake Tanganyika during his recent expedition to Eastern Africa. As Mr. Moore has shown in our columns (NATURE, vol. lviii. p. 404), there are two faunas in Lake Tanganyika, the normal fresh-water, and what Mr. Moore proposes to call the "Halolimnic" group, the latter being evidently of marine origin. That this is the case has been conclusively shown by Mr. Moore's studies of the splendid collection of molluscs which he obtained in that lake. It would therefore be naturally expected that the results of the examination of Mr. Moore's fishes, which has been undertaken by Mr. Boulenger, would likewise show the presence in Lake Tanganyika of a certain number of "Halolimnic" or marine fishes. This, however, does not prove to be the case. Mr. Moore's fishes, Mr. Boulenger informs us, do not yield any such startling results as the mollusca and other invertebrates. The fishes of Tanganyika, though very novel and very remarkable, do not embrace any marine forms. This may be due, as Mr. Boulenger observes, either to the origin of the present fish-fauna not reaching as far back in time as that of the molluscs, or to the incompleteness of Mr. Moore's series. The latter explanation is probably the correct one, as Mr. Moore met with great difficulty in dredging in the deeper water of Tanganyika, only one fish having been obtained from a depth of about 400 feet. This (*Bathybates ferox*), although of a new genus and species, belongs to the widely-spread African family Cichlidæ.

Altogether, the fishes obtained by Mr. Moore in Lake Tanganyika are referred by Mr. Boulenger to thirty-five species, belonging to the families Serranidæ, Cichlidæ, Mastacembelidæ, Siluridæ, Cyprinidæ, Characinidæ, Cyprinodontidæ and Polypteridæ. It would thus seem that in general characters the Tanganyikan fish-fauna, so far as it has been yet ascertained, does not materially differ from the fish-faunas of the other great African lakes, but that most of the Tanganyikan species and many of the genera are distinct, the family Cichlidæ alone having furnished types of ten new genera in the present collection.

In his introductory remarks to the present memoir, Mr. Boulenger has taken the opportunity of putting together lists of the fishes already known to be found in Lake Nyasa, Lake Tanganyika, Lake Victoria and Lake Rudolph. From the first of these we are now acquainted with thirty-seven species, from the second with forty-three, from the third with only nineteen, and from the fourth (Lake Rudolph) with only nine. These lists, Mr. Boulenger points out, must be taken as giving a very inadequate idea of the piscian inhabitants of the great African lakes, owing to the manifest incompleteness of the collections upon which they are based. Of the other lakes nothing whatever, unfortunately, can be said at present, only one species of fish having been yet brought from the great Albert Nyanza. It is evident, therefore, that there is a fine field for the enterprising ichthyologist in the great African lakes.

PROFESSOR ALFREDO ANTUNES KANTHACK.

By the death of Prof. Kanthack the science of pathology has lost one of its ablest and most indefatigable exponents, and the University of Cambridge, for the second time in less than fifteen months, a brilliant occupant of its chair of Pathology.

At the closing meeting of the Pathological Society, last summer, it was noticed by several of Prof. Kanthack's friends that he appeared to be less energetic and vigorous than usual. After this the work of the long vacation appears to have told upon his health so seriously, that even during the course of a short holiday it was remarked at the opening of the Pathological Laboratories at Liverpool that he still appeared to be far from well. In spite of this few were prepared to learn, about the middle of December, that Prof. Kanthack was suffering from a malignant growth, the symptoms of which had first been indicated by jaundice and severe abdominal pain—a diagnosis that was afterwards confirmed. He died on December 21, 1898.

Alfredo Antunes Kanthack was the second son of Emilio Kanthack, Pará, Brazil, and Victoria his wife, both born in Permambuco. He was born at Bahia on March 4, 1863, and spent the first few years of his life in Bahia and Ceará, Brazil. He was brought to Germany in 1869, being placed under the care of Pastor Hoppe of Artlenburg on the Elbe, father of the present Prof. Edmund Hoppe of Berlin. In 1870 he was sent to Hamburg, where he was first taught by a strict disciplinarian, "a tyrannical pedagogue but excellent teacher of elementary subjects." During this period he is described as "being by no means brilliant but extremely diligent." Early in 1875 he went to school in the Wandsbeck Gymnasium, near Hamburg. In 1876 he was transferred to the Gymnasium of another Prussian Government school at Lüneburg, and in 1878 to the Gymnasium at Gütersloh, where he greatly distinguished himself. In 1881 he came to Liverpool, where his parents were then residing, and continued his studies for a short time in the Shaw Street College (Classical Department). In 1882, after passing his University of London matriculation examination, he commenced his arts curriculum, and continued his studies in science and medicine under Mitchell Banks, Caton, Mott and other well-known teachers of the Liverpool medical school, graduating B.A. in 1884, B.Sc. in 1886, M.B. and B.S. (in each instance with honours), F.R.C.S. Lond. in 1888, and M.D. Lond. in 1892; whilst in 1897 he proceeded to the degree of M.A., and became a Fellow of the Royal College of Physicians, London. After completing his medical curriculum Dr. Kanthack, in 1889, proceeded to Berlin, and there, as part of the result of his studies under Virchow and Krause, he contributed an admirable paper to Virchow's *Archiv* on the histology of the larynx, a paper which at the time gave rise to a lively controversy, Dr. Kanthack maintaining his original thesis with marked ability and success. Whilst in Berlin, too, he worked under Koch, and here, as in the pathological laboratories, he attracted the attention and received the special encouragement of his teacher. Shortly after his return from Berlin, and probably as the result of an expression of opinion on the part of his teachers—Virchow and Koch—he was appointed one of the Special Commissioners along with the late Dr. Beaven Rake and Dr. Buckmaster, by a joint Committee of the Royal College of Physicians, the Royal College of Surgeons and the Executive Committee of the National Leprosy Fund, to investigate the prevalence, the pathology and the treatment of leprosy in India.

In 1891 Dr. Kanthack was appointed John Lucas Walker Scholar under the late Prof. Roy, and in succession to Dr. William Hunter. During the time that he held this scholarship in Cambridge, he published, along with Mr. Hardy, a paper on the wandering cell in the mammalia, in the *Journal of Physiology*, and a paper on the behaviour of wandering cells, in the *Proceedings* of the Royal Society, vol. lii. These papers are of special importance as indicating that, although thoroughly acquainted with Metschnikoff's work and all that that author had to advance in support of his phagocytic theory, Dr. Kanthack had made, during his stay in Germany, an accurate forecast of the destination to which the work that was being carried on in Germany by Koch's pupils

would eventually lead. During this period, too, he carried on an investigation on Madura Foot, and compared mycetoma with actinomycosis; this paper appeared in the *Journal of Pathology* and in the *Transactions* of the Pathological Society. In 1892 Dr. Kanthack became medical tutor at the Royal Infirmary, Liverpool, and in order that his bacteriological training might be utilised, a special demonstratorship of bacteriology was founded for him. The following year the authorities at St. Bartholomew's Hospital retained Dr. Kanthack's services as director of the Pathological Department in the School and Hospital and Lecturer on Pathology and Bacteriology; and a year later gave him the appointment of Curator of the Museum. In addition to the teaching and routine work of this period he contributed numerous notes and observations to the *Transactions* of the Pathological Society, and, probably for the purpose of systematising his teaching work and saving time in the explanation of details, he in 1894 published, in conjunction with Dr. Rolleston, a "Manual of Practical Morbid Anatomy"; and in the following year, along with Dr. Drysdale, a work on "Practical Bacteriology." Both these works give evidence of wide reading and of an accurate knowledge of literature thoroughly up to date. When Prof. Roy became so ill that it was evident that he could no longer carry on his professorial work, and in all probability would never again be able to take up the duties of his chair, Dr. Kanthack was appointed Deputy Professor of Pathology. The work of this post he carried on simultaneously with his duties at St. Bartholomew's Hospital, making the return journey between London and Cambridge several times a week. This, for a man who, a short time before, had recovered from a severe attack of typhoid fever, involved a very great physical strain; and early in 1897 Dr. Kanthack resigned his post at St. Bartholomew's and gave undivided attention to his work in Cambridge, where, on Prof. Roy's death, he was appointed Professor of Pathology.

Of Prof. Kanthack's influence on the study of pathology and bacteriology in this country, it is as yet too early to speak, though there can be little doubt that, apart from the work that he himself initiated, that of his pupils must ultimately leave a deep impress on the scientific medicine of our time and that immediately to follow. In many ways Prof. Kanthack was an ideal teacher. He exerted great personal influence over the young men who were brought into contact with him. His reading was very wide, so that, possessing a retentive memory, he was able to store up an enormous amount of accurate information which he could always bring to bear on the work that he had in hand. He was thus able to make a profound impression on his pupils. He had a sufficient amount of dogmatism in his manner and method to inspire them with confidence in his teaching, and to give those who were looking to him for guidance a sheet-anchor to which they might hold until they were thoroughly able to take their bearings for themselves. From his extensive reading, too, which, as already indicated, was always kept well up to date, he was able to determine at once what special points remained to be worked out in connection with the various subjects occupying the attention of the scientific world; whilst his keen critical faculty enabled him to mark the flaws in experiment or argument in published work that came under his notice, so that he was always able to set his pupils on to work which should shed some new light on the various questions attacked, and to gather facts and information which would help him in the solution of the problems on which he himself was engaged. Those of his pupils who knew him best regarded him with feelings of the deepest affection—to them the loss is intensely personal. In 1895 Prof. Kanthack married a Liverpool lady—Miss Lucie Henstock—the daughter of the late John Henstock, Esq., of Liverpool.

NOTES.

IN retiring from the presidential chair of the Paris Academy of Sciences, at the meeting on January 2, M. Wolf referred to the changes which had occurred in the list of members and correspondants during last year. In the section of geometry, Prof. Cremona was elected correspondant in succession to Prof. Brioschi. The section of astronomy lost M. Souillart, and the two vacancies caused by his death and that of Dr. Gould, have not yet been filled up. There is a vacancy in the section of geography and navigation, caused by the death of M. Manen, and also a vacancy in the section of chemistry, caused by the death of Prof. Kékulé. In the section of mineralogy, M. Depéret was elected to succeed the late M. Pomel, and Prof. Marsh to succeed the late Prof. Hall. There are two vacancies in the section of botany, one caused by the death of Baron von Mueller. The section of rural economy has lost Marquis Menabrea and M. Demontzey by death, and the vacancies have not yet been filled up. Two vacancies also exist in the section of anatomy and physiology, on account of the deaths of Prof. Lovén and Prof. Steenstrup. In the section of medicine and surgery Prof. von Leyden has succeeded Prof. Virchow, who has been elected foreign associate of the Academy; and Prof. Mosso has succeeded the late Prof. Tholozan.

THE Council of the Royal Institute of Public Health have awarded the Harben Gold Medal for 1899 to Lord Lister, P.R.S., in recognition of his eminent services to preventive medicine. Prof. William R. Smith, who has been appointed Harben Lecturer for the year 1899, has chosen "Diphtheria" as the subject for his lectures.

A REPORT has reached us from Mr. L. Small, of Denver, of the discovery of a huge fossil Dinosaur that must have been about 130 feet in length. The remains were found by Prof. W. H. Reed, of Wyoming, in Jurassic strata, near Laramie, and indicate an animal much larger than any form that has been previously obtained.

IN addition to the New Year honours referred to last week, Sir Charles Cameron, medical officer of health for the City of Dublin, has had the Order of C.B. conferred upon him.

FATHER RODRIGUEZ DE PRADA has been appointed director of the Vatican Observatory.

THE annual general meeting of the Royal Meteorological Society will be held on Wednesday next, January 18, when the report of the Council will be read, the election of Officers and Council for the ensuing year will take place, and the President (Mr. F. Campbell Bayard) will deliver an address on "The government meteorological organisations in various parts of the world."

ON Tuesday next (January 17), Prof. E. Ray Lankester delivers the first of a course of ten lectures at the Royal Institution on "The Morphology of the Mollusca." On Thursday (January 19), Mr. A. Savage Landor will begin a course of three lectures on "Tibet and the Tibetans." The Friday evening meeetings of the members will commence on January 20, when Prof. Dewar will deliver a discourse on "Liquid Hydrogen."

THE ninth International Congress of Ophthalmology will meet at Utrecht from August 14 to 18. Only the English, French, and German languages will be employed. There will be three sections—one for anatomy, pathological anatomy, and bacteriology; one for optics and physiology; and one for clinical and operative procedures. There will be a secretary for each language as follows: English, Dr. A. McGillivray, Dundee; French, Dr. A. Dufour, Lausanne; German, Dr. A. Siegrist, Bâle.

BY making use of the exceedingly low temperatures that can now be obtained, a very simple method for exhausting X-ray and other vacuum tubes presents itself. An example of this was given by Prof. Dewar at a recent meeting of the Royal Society, at which he was able to produce an almost perfect vacuum. By dipping the end of a closed tube filled with air into liquid hydrogen, the air quickly condensed at the bottom in a solid form. It then only remained to separate from the rest that part of the tube from which the air had been so removed, by heating and sealing off, and the tube was found to possess an extremely high vacuum. In fact, so perfect was the vacuum that it was difficult to pass an electric current through it. One great advantage of this mode of procedure is that in the above case only one minute was taken to obtain the required result.

WE regret to see, in the *Electrical Review*, the announcement of the death of Dr. Eugen F. A. Obach, at the comparatively early age of forty-six years. He was born in Stuttgart, of Swiss parents. In 1875 he obtained his degree of Doctor of Philosophy at the University of Leipzig. After spending a few years in electrical engineering, Dr. Obach devoted himself mainly to the study of the chemistry of gutta-percha and india-rubber, the result of his extensive and varied knowledge of these substances being embodied in his Cantor Lecture delivered before the Society of Arts. A long abstract of these lectures appeared in NATURE in June last (vol. lviii. p. 136). Shortly after that time his health failed, and even prolonged rest from work brought about no improvement, and he died on December 27 at Graz, Styria. Dr. Obach had been a frequent contributor to the literature of electrical science since 1875, about a score of papers being published in the English and German technical journals or in the *Proceedings* of scientific societies.

DR. REINHOLD EHLERT, distinguished by his studies in seismology, has lost his life by an Alpine accident on the Susten Pass. Among other valuable seismological works, he wrote a treatise on "A comparison, explanation, and critical estimate of the most important seismometers, with special reference to their practical utility." This work was *couronné* by the philosophical faculty of the University of Strasburg, where Dr. Ehlert conducted his investigations.

REUTER reports from Copenhagen that Captain Daniel Brunn has decided to organise an expedition next summer to search for traces of Herr Andrée and his companions in the neighbourhood of Eastern Greenland. The expedition will start from the east coast of Iceland, and proceed by way of Jan Mayen Island to the vicinity of Cape Barclay, on the East Greenland coast.

THE *Pharmaceutical Journal* reports the opening of a chemical and pharmaceutical laboratory in Rajkote, the seat of the Government in the province of Kathiawar, Western India. The building is the gift of Azam Laxmon Meram, who contributed 30,000 rupees for its construction; and its equipment has been provided from the State Joint Fund. The object for which the building has been primarily founded is for improving the practice of native medicine and for making known valuable Indian remedies to Western science, and also to ascertain which native herbs may be made more adaptable to science; and it is hoped that eventually it may further the progress of bacteriology and sanitary science. The director of the laboratory is Mr. H. L. Lee.

THE present position of the Röntgen rays in military surgery was described by Major J. Battersby in a paper read before the Röntgen Society on Tuesday. Major Battersby was selected for service in charge of the Röntgen ray apparatus in the Sudan, where the temperature varied from 100 to 122 degrees F. in the shade; and his paper was based upon his experience in this campaign. After the battle at Omdurman 121 British wounded were conveyed to the surgical hospital at Abadieh. Of that number there were 21 cases in which the bullet could not be found, or its absence proved by ordinary methods. In 20 out of these 21 cases an accurate diagnosis was arrived at with the help of the rays, the odd case, who was suffering from a severe bullet wound in the lung, being too ill for examination at the time. The senior medical officer in charge of the hospital said:—"The Röntgen rays proved of invaluable assistance in localising the exact position of bullets, and in many cases rendered probing of wounds unnecessary. . . . In many cases the X-rays prevented much suffering to the patient, which would have been caused by probing, the use of the finger, or enlarging the wound in the ordinary search for the bullets, as the skiagraph at once indicated the exact position of the bullet. In other more complicated cases the Mackenzie-Davidson method localised the exact position of the bullet, so that the surgeon was at once able to come to the conclusion if operative interference was judicious or otherwise. If considered advisable, the removal of the bullet was much facilitated by the diagram previously indicating exactly where the projectile was to be found." With regard to apparatus, the most serious difficulty at present is the best method of generating the primary electrical current for charging the storage batteries, or working the coil direct. Primary batteries, for many reasons, are unsuitable and not to be recommended. In the Sudan a small dynamo, driven by means of a tandem bicycle, answered admirably, and was readily transported by rail and river to Abadieh; but as at present constructed, it is unsuitable for mule, camel, or human transport. An ideal apparatus would consist in a statical or friction machine, some modification, for instance, of Mr. Wimshurst's, by which the focus tube could be excited direct. In such a design many physical difficulties will occur, but they are not insurmountable. If it is achieved, it will enable the present apparatus to be reduced very considerably by dispensing with primary and storage batteries, dynamos, bicycles, and induction coils.

WITH reference to the landslip from the Sasso Rosso, which destroyed several buildings at Airolo on December 27, 1898, the Zürich correspondent of the *Times* states that Swiss geologists are of opinion that the landslip is by no means over, and that a mass of rocks equal to that which fell last week has yet to come away. It is hoped that the detachment will take place in smaller masses, and that no slip exceeding the present (400,000 cubic metres in volume) is to be apprehended. The summit of the Sasso Rosso is 2300 metres above the sea level, and 1200 above Airolo, and the falling rocks reached the village with a velocity of 15 to 20 metres per second. The present danger lies in the rocks which remain suspended on the flank of the mountain. Should these give way, the village and the southern exit of the tunnel would be endangered by the avalanche, a risk which is increased by recent heavy rain and snow. Compared with other similar avalanches, the amount of débris already fallen is not excessive; at Elm the fall exceeded 11,000,000 cubic metres, at Goldau it was 25,000,000, and the historic landslip at Brienz in 1749 was estimated at 50,000,000 cubic metres.

THE New York Zoological Society has issued the third number of its *News Bulletin*, in which the progress of the work of transforming South Bronx Park into a Zoological Park is described and illustrated. Seven months ago the New York Zoological Park was a tract of wild land, but since then several of the animal houses have almost been completed, and other enclosures have been made. New York City has voted 30,000 dollars as a maintenance fund for six months, both for the care of the animals and the care of the Park, and is expending 62,000 dollars in the development of roads, walks, drains, and other ground improvements. It is a matter for congratulation that

the Zoological Park appears to have become one of the established institutions of the City of New York. The magnificent site, and the fine buildings and enclosures which will eventually be erected upon it, will give the people of the metropolis of Greater America reason to be proud of their Zoological Park.

DR. ROBERT MUNRO writes to the *Glasgow Herald* with reference to the archæological remains recently discovered in the estuary of the Clyde (see NATURE, vol. lviii. p. 488), and with which his name has been associated. He desires it to be known that he does not endorse the opinions that have been promulgated as to the age, structure, and marvels of the Dumbuck crannog, for he regards it neither as a pile-structure nor as a monument of Neolithic times.

THE curator of the Perak Museum at Taiping reports in the Blue Book on the Straits Settlements (C-9108 of 1898) that the museum is now overcrowded, and that there is consequently much difficulty in arranging the collections in their natural sequence, while there is practically no room for new specimens. The Taiping collections are specially rich in the ethnological and mineralogical branches, and the zoological specimens have recently been greatly improved. The photographic and botanical branches were extended during the year, and the museum now contains a valuable section allotted to economic botany. Investigations were carried out, with satisfactory results, on the subject of insects attacking coffee, rice, and other agricultural products, and some experiments were made in connection with tapping rubber. Discussion has been going on as to constituting the museum at Taiping a central museum, supported by all the Federated Malay States. The curator at Taiping suggests that local museums, of which one has been in existence for several years in Selangor, and which, it is to be hoped, will soon be established in the other States, might either be affiliated to, or form branches of, the Federal museum. On the other hand, the British Resident at Selangor urges that the existence of a local museum creates and sustains in the minds of the community an interest in local products, their sources and uses, which cannot fail to be beneficial and deserving of encouragement, and it cannot be argued that people in Selangor or the Negri Sembilan will obtain any advantage from a museum in Perak, however complete, which few of them will probably ever see.

THE January number of the *Reliquary and Illustrated Archaeologist* contains a note on a paper recently read before the Society of Antiquaries by Mr. P. Norman, on the discovery, at Millfield, Keston, Kent, of a shallow, circular pit containing nearly a thousand chips, flakes, and cores of flint. Mr. Norman drew attention to the fact that a very large proportion of the well-shaped flakes had lost their pointed end, consisting of about one-fourth or one-third part of the entire flake. This had evidently been broken off purposely, and, as none of the points were found among the débris, while many butt-ends remained, it seemed probable that the flakes were produced for the sake of their points. These were broken off and used as arrow-heads, or for some purpose requiring sharp angular points, and thus dispersed about the surface of the surrounding country. A number of cores from which the flakes had been struck, and some large pebbles which had apparently served as hammers for detaching the flakes therefrom, were found lying among the fragments of flint on what must have been the floor of a Neolithic workshop. The hut in which this ancient industry was carried on was about fourteen feet in diameter, and its site was found under an accumulation of earth about two feet thick. Evidence was given that the Millfield pit formed one of the remarkable group of Neolithic hut circles on Hayes Common, some of which had been excavated and described ten years ago by Mr. George Clinch.

To determine the probable meteorological conditions likely to prevail along the path of the total eclipse of the sun, which will occur in the Southern States of America on May 28, 1900, Prof. F. H. Bigelow obtained observations of the state of the sky, and other meteorological conditions along the path of totality, for the period from May 15 to June 15 in the years 1897 and 1898. The results for the former year have already been referred to (vol. lvii. p. 159), and those for the year 1898, containing reports from eighty-seven stations, are given in the latest number of the *Monthly Weather Review* (September 1898). Last year's observations give precisely the same result as was obtained in 1897, namely:—The weather conditions in the interior of Georgia and Alabama were better than in Virginia, North Carolina, South Carolina, Mississippi, and Louisiana; and it would be much safer for the eclipse expeditions to locate their stations in the northern portions of Georgia and Alabama, upon the southern end of the Appalachian Mountains, where the track crosses the elevated areas, than nearer the coast-line in either direction north-eastward towards the Atlantic coast, or south-westward towards the Gulf coast; on the coast itself the weather is more unfavourable than in any other portion of the track.—The inquiry will be repeated during May and June of the present year.

THE reports issued by the Meteorological Office show that, notwithstanding the stormy character of the weather during December, and the almost continual succession of atmospheric disturbances which reached our coasts from the Atlantic during the latter part of the month, the rainfall during that period was only in excess of the average in the north of Scotland, the north of Ireland, and the southern and central parts of England. In the Hebrides, which experienced the full force of many of the storms, the excess was most marked, rain having fallen at Stornoway on every day of the month, on five occasions the fall exceeding an inch, and the total amount measured being little short of 15 inches, or more than 9 inches above the average. There was a considerable deficiency in the east and west of Scotland and the north-east and north-west of England. Reckoning from the beginning of the year, the only marked excess above the average is 16 inches in the north of Scotland. In all other districts, except Ireland, there is a considerable deficiency, the greatest being about 7·6 inches in the south of England.

THE "enclosed" type of alternate-current arc-lamp is much steadier in burning than its predecessors, it is therefore particularly well suited to photographic investigations as to the nature of arcs in general, using rapidly moving photographic plates. Mr. N. H. Brown, in the *Physical Review*, vol. vii. pp. 210–216, 1898, describes his experiments made with an "enclosed" arc. The pictures obtained are not simply broad discontinuous bands of light; they exhibit, as a rule, a symmetrical arrangement of bright patches, in more or less regular alternation, the second patch being "reversed" to the first—like its image seen in a plane mirror. The front end of each patch makes an appreciable angle with the diameter of the plate, representing that the arc starts from one side, and then from the other, successively. The shape of the back ends of the bright patches indicates that the light dies out first near the carbons, and later near the middle of the arc-space. The shape of the back and front ends of the bright patches does not seem to depend upon whether the current curve is or is not a true sine function.

PROF. JAMES S. STEVENS'S "Study of various styles of cross-wires," in the *Journal of Applied Microscopy* for October, deals with a subject of such importance in astronomical and other observations, that a short *résumé* of the conclusions may even now be of interest. Four styles of crossed wires were experimented on; in the first, the intersection of two wires

forming an **X** is brought into coincidence with the given fixed line; in the second, one wire is superposed on the line; in the third, this line bisects the space between two parallel lines; and in the fourth, the reference line is adjusted at one side of the movable parallel lines at a distance from one of them equal to their distance apart. Four observers were selected, each being required to make twelve settings with either arrangement; firstly with time unlimited, secondly with time limited to two or three seconds, and thirdly with each of the four settings taken in alternation. The probable error of the mean of each group of twelve observations was calculated by the Theory of Least Squares. With one exception the method of intersecting wires is found to give by far the largest probable error, and may easily be classed as the poorest method. When the reference mark upon which the wires are to be set is of the same order of magnitude as the movable wire, the method of superposing one upon the other gives the best results. Lastly, when the reference mark is larger, such, for example, as the lines on a graduated scale, the third or fourth method should be used, the choice between these two depending upon the observer. It is thus remarkable that the cross-wire arrangement adopted in the older transit circles should be so inferior to other arrangements.

IN some notes on the geology of Syria (*Bericht der Senckenb. naturf. Gesellsch.*, Frankfurt, 1898), Dr. F. Kinkelin records fossils from the Cretaceous and Eocene formations in a number of localities. It is well known that in Palestine strata from the base of the Upper Cretaceous to the Nummulitic limestones form one great geological group, and it may be judged from the facts made known by Dr. Kinkelin that a corresponding series occurs in northern and central Syria. A new species (*Cardium Dayi*) is described from strata yielding *Inoceramus concentricus* and *Vola* (*Pecten*) *aequicostata*.

REMAINS of fossil Jerboa (*Alactaga saliens fossilis*) have been described, by Dr. A. Nehring, from the Pleistocene strata of Westergeln, between Magdeburg and Halberstadt (*N. Jahrbuch f. Mineralogie, &c.*, 1898, Bd. II.)

THE development of the pattern of the wings of butterflies in the pupa forms the subject of a paper by Countess M. von Linden, in the *Zeitschrift für wissenschaftliche Zoologie*, Band 65, Heft I. The principal species discussed, and illustrated in the three plates which accompany the article, are *Papilio podalirius* and *machaon*, *Thais polyxena*, and *Vanessa levana* and *urticae*. This paper is followed by one upon a similar subject, by Dr. M. Baer, who discusses the structure and coloration of the wing-scales in butterflies. The author recognises three different classes of colour, viz. (1) pure colours, due exclusively to pigment; (2) optical colours, due to refraction; (3) mixed colours, due to the effects of pigment and refraction combined.

THE *Proceedings* of the tenth annual meeting of the Association of Economic Entomologists (U.S. Department of Agriculture, Division of Entomology, *Bulletin* No. 17, New Series) include a variety of short papers on insects of various orders, and the best means of destroying them. Prof. Howard's observations on the ease with which Chalcid parasites of *Coccidae* can be introduced from one country to another, are of considerable importance. There is also a paper by Mr. T. D. A. Cockerell, on "Entomological Ethics," containing some suggestions which may not be unworthy of the attention of those who are responsible for the management of museums and other public collections.

AMONGST the botanical papers read at the last meeting of the American Association for the Advancement of Science is one by Dr. Erwin F. Smith, describing some observations he has made on an organism recently isolated from and believed to be responsible for a disease which appears in sweet corn. It was originally found by Stewart occurring in enormous numbers in the vascular bundles of corn, making the leaves flabby or shrivelled. It is a motile bacillus and is provided with one polar flagellum, and grows in all ordinary culture media, producing a yellow colour both in the latter and in the host plant. It grows best in the presence of cane-sugar, and very striking differences are observed when it is inoculated on to slices of turnips and slices of beetroot respectively, the growth being ten to fifty times as abundant in the case of the latter. In this characteristic may possibly be found an explanation of why sweet corn is attacked in preference to common corn. It has been found in New York and Michigan States, and may be looked for, says its discoverer, in all parts of the United States.

DR. G. AGAMENNONE has contributed to the *Atti dei Lincei* (vii. 11) some interesting statistics relating to the earthquake at Hayti on December 29, 1897. The position of the epicentre was roughly in latitude 19½° N., longitude 71° W. As mentioned in a former note in NATURE, Dr. Agamennone had previously found considerable difficulty in calculating the velocity of propagation of the Labuan shock, which he attributed to the differences in sensitiveness of the instruments by which it was recorded at various stations. That this explanation was the correct one, is confirmed by analogous observations connected with the Hayti earthquake. Thanks to the existence of a Cecchi seismograph at Port-au-Prince, whose readings could be compared with those taken at Catania and Ischia, the velocity of propagation of different waves was calculated, and was found in no case to reach 10 kilometres per second; and the swiftest waves, probably longitudinal in character, were followed by waves of long period whose superficial velocity seems to have averaged 3 kilometres per second. But it is pointed out that in the absence of the Port-au-Prince Observatory, a comparison of the records made at Toronto and in Europe would have given improbably high values for the velocity of propagation, consequent upon the Toronto instrument being insensible to the first waves which affected the European seismographs.

THE buildings of Oxford, from an engineer's point of view, form the subject of an illustrated article in the January number of the *Engineering Magazine*.

A BRILLIANT heliogravure of Dr. Sidney Coupland, recently appointed Commissioner in Lunacy, appears in the *Middlesex Hospital Journal*. Dr. Coupland has been connected with Middlesex Hospital for many years, in the department of pathological anatomy.

AN instructive description of the great boulder of gypsum, recently found at Great Crosby, is given by Mr. T. Mellard Reade in a pamphlet, a copy of which has been sent to us. A picture of the boulder upon the pedestal erected for it by the District Council of Great Crosby, forms the frontispiece of the pamphlet.

THE new volume of the *Geographical Journal*, containing the six monthly parts from July to December 1898, has been published. Like previous volumes, the present one is filled with interesting papers read before the Royal Geographical Society, articles on topics of geographical importance, a monthly record of contributions to geography in various parts of the world, an invaluable bibliography of current geographical literature, lists of new maps, and numerous coloured maps to illustrate the contents.

A COPY of the second number of the *Zambesi Mission Record* has been sent to us. The periodical is to be published about four times a year, and is concerned with the Catholic missions in

the area under the rule of the British South Africa Company, north and south of the Zambesi. Among the articles in the present number is a very interesting one on some South African beetles, by the Rev. J. O'Neil, S.J., illustrated by photographs of the chief species described. The magazine can be obtained from the Rev. A. M. Daignault, 114 Mount Street, London, W.

THE annual report (new series, vol. ix.) of the Geological Survey of Canada, referring to the operations of the Survey in 1896, has been received. The volume comprises 816 pages. It is accompanied by five maps and illustrated by twenty plates, besides a number of figures in the text. The several parts composing the volume have been issued separately, and most of them have been referred to in these columns. Dr. George M. Dawson's summary report, occupying 144 pages, shows that the Canadian Survey accomplished work of great economic importance in 1896, and added to scientific knowledge by original observations and deductions, and by exploration of new ground in the field.

A SERIES of monthly star maps has been prepared by Mr. Walter B. Blaikie, and issued by the Scottish Provident Institution in a blotting-book. There are two maps for each month, one showing the aspect of the sky in the latitude of London, at 10 p.m., when looking north, and the other the southern aspect. The stars are printed in gold on a blue ground, and the positions of the chief planets visible are indicated. In addition to the maps, which will enable beginners easily to find their way among the constellations, a number of notes on interesting astronomical objects are given by Mr. Blaikie. The idea of issuing maps of this kind from an assurance office is an excellent one, and it has been well carried out.

WE have received the *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, Vienna, containing papers presented to the section of mathematics and natural sciences during the period from January 1897 to March 1898. The report is divided into four parts, referring to different branches of science, and each part is published in several divisions. The first part contains papers on natural sciences; the second comprises (*a*) papers on mathematics, astronomy, physics, meteorology, and mechanics, and (*b*) papers on chemistry; and the third part contains papers on anatomical and physiological subjects, excluding purely medical matters. Many of the papers have already been referred to in these columns, and with the others now before us they make a valuable addition to scientific knowledge.

THE question as to the best means of isolating a freezing mixture is one of considerable practical importance in chemical and physical work. In the current number of the *Berichte*, Prof. W. Hempel describes a series of comparative experiments undertaken by him to settle which substance was most suitable for ordinary work. Starting with a temperature of about $-75°$ to $-80°$ C., produced by solid carbon dioxide and ether, the rate of rise of temperature with time was measured, and, as a result, eiderdown was found to be the best insulator, wool carefully dried at 100° C. being nearly as good, and having the advantage of cheapness. Three samples of vacuum tubes, of the pattern invented by Prof. Dewar, were also tried, and were found to give very varying results amongst themselves, and all being much inferior in insulating power to either eiderdown or cotton wool. Thus with eiderdown a rise of 12° C. occurred in eighty-eight minutes, with dry wool a rise of 20° to 24° C. in the same time, whilst the three vacuum-jacketed tubes gave under the same conditions rises of 65°, 69°, and 39° respectively. The results would seem to show that trustworthy Dewar tubes cannot be bought commercially.

THE additions to the Zoological Society's Gardens during the past week include a Huanaco (*Lama huanacos*, ♂) from Punta Arenas, presented by Mr. Henry F. Fox; a Crossbill (*Loxia curvirostris*), European, presented by Mr. H. O. Blanford; two Delalande's Geckos (*Tarentola delalandi*) from West Africa, presented respectively by Mr. Percy Leach and Mr. H. Munt; three Grey Squirrels (*Sciurus cinereus*) from North America, two Dorsal Squirrels (*Sciurus hypopyrrhus*) from Central America, three Nose-crested Iguanas (*Iguana tuberculata rhinolophus*) from Nicaragua, a —— Iguana (*Iguana*, sp. inc.) from Tropical America, deposited; a Leopard, Black variety (*Felis pardus*), from Africa, three Brazilian Caracaras (*Polyborus brasiliensis*) from South America, two Warty-faced Honey-eaters (*Xanthomyza phyrgia*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

COMET CHASE.—This comet, which is a faint object and difficult to observe, has the following ephemeris for the present week:—

Ephemeris for Berlin Midnight.

1899.		R.A. (app.) h. m. s.		Dec. (app.) ° ′
Jan. 13	...	11 8 48	...	+30 54·6
15	...	9 15	...	31 17·9
17	...	9 35	...	31 41·2
19	...	9 48	...	32 4·6
21	...	11 9 55	...	+32 27·7

Its brightness is now about the same as that at the time of its discovery, and is on the decrease.

ARTIFICIAL MOON MARKINGS.—Mr. S. H. R. Salmon has sent to us a series of slides which are of great interest, since they appear to represent portions of lunar landscapes, and are astonishingly like the real photographs of them. In fact, among all artificial methods of trying to produce lunar effects without the intervention of any hand work this is, as far as we know, the most successful. The process Mr. Salmon employs is very simple and can be easily repeated by any one. It is only necessary to smear a little paste on to a glass slide, and gently warm it from below with a spirit-lamp until it is dry. Observing it then with a microscope, we are confronted with this lunar-like appearance. The slides which we have before us represent many variations of lunar formations. In this one we see a small craterlet on the wall of a large crater, while in another we have rills widening now and again into craterlets. In a third slide we have a large crater, very like some on the moon, showing beautifully the gradation of tone on the surrounding wall. All the markings are, as Mr. Salmon states, perfectly accidental, and can be seen with the microscope. The slides before us are the result of a first attempt at micro-photography on the part of Mr. Salmon, and he is to be congratulated on obtaining such excellent results.

A NEW DOME FOR EQUATORIALS.—The natural evolution in the construction of domes under which equatorials are housed is the elimination of the shutter. Shutters, if they are not perfect, are the causes of so many evils in an observatory, for they may leak, jam, break, and in several other ways do indirectly damage to a valuable instrument. There are several ways in which a dome can be erected and found to work satisfactorily without their presence, and one, set up at Greenwich in 1891 for a transit instrument, has met with marked success. In this case the dome consists of two halves, and as the aperture is required only in the meridian, these are made to roll back one east and the other west. More recently the idea has been extended to the new altazimuth, also at Greenwich; but here the halves are mounted on a ring girder, to allow the aperture to take up any required azimuth. In both these cases the openings had parallel sides.

A later modification for equatorials, due to Messrs. T. Cooke and Sons, of York, is described and illustrated in the current number of the *Observatory* (January), and here the opening is wedge-shaped. The arrangement, as described by the makers, is the following.

"Our object was to do away with the usual shutter covering an opening in the dome. To carry this into effect, the dome is

mounted on a horizontal revolving ring or annular frame, provided with rollers at suitable intervals apart, which roll on a fixed circular track or rail firmly secured to the wall of the building. The dome is made in two halves, divided in a vertical plane through the centre, and hinged at one extremity of this division at two of their adjacent corners to a pin fixed to the revolving ring or annular frame above mentioned. At the opposite corners of the two halves of the dome are fixed rollers, one at each corner, and two other rollers are supplied 90° from the first pair, one in each half. These rollers roll on the surface of the revolving ring, or on short races, in such a manner as to support the two halves of the dome on the horizontal revolving ring, and permit of their being opened or closed. The opening is, of course, a wedge-shaped one. The two halves of the dome being mounted on the ring, which is capable of revolving by means of the rollers resting on the circular rail, the wedge-shaped opening in the dome can be brought to face any part of the sky."

It may be mentioned as a further advantage of this arrangement that in the winter season, when the dome may be covered with snow, it does not prevent it being opened, as is so frequently the case with domes with shutters; and, furthermore, it gives facility for any design of dome being used, which a shutter renders impossible.

A NEW ASTRONOMICAL PERIODICAL.—We have received a circular from the Manora Observatory in Lussenpiccolo, informing us that a new illustrated astronomical periodical will be published from that observatory, with Herr Leo Brenner as editor. Ten numbers will be issued during the year, and these altogether will contain 400 pages and over 100 illustrations. The price for the ten numbers is stated to be twelve shillings, post free.

CONFERENCE OF THE INTERNATIONAL GEODETIC ASSOCIATION.[1]

THE twelfth general conference of the International Geodetic Association was held at Stuttgart on October 3–12, 1898. Fifteen countries of the nineteen composing the Association were represented. Of the thirty-seven delegates present fifteen came from Germany, five from France, three from Italy, two from Switzerland, two from Japan, and one each from Belgium, England, the Netherlands, Austria-Hungary, Russia, Sweden, Spain, Mexico, and the United States. Besides the delegates, eighteen invited guests appeared, making a total of fifty-five persons present at the meetings. By far the greater part of the time was naturally taken up in reading the regular reports by the delegates on the geodetic work accomplished in their respective countries since the last general conference.

Of special interest was the contribution by Prof. Helmert on the activity of the Central Bureau of the Association at Potsdam. The following work was described: (1) The systematic deviations of the plumb line in connection with the European arc on the 52° of north latitude. (2) The international latitude service. (3) Absolute determinations of gravity. The international latitude service will be inaugurated during the summer of 1899 at four stations under the direct control and at the expense of the Association. Observations at two additional stations will be undertaken, for which the Central Bureau will supply only a part of the funds necessary. Although the mathematical conditions are not essentially changed by the introduction of Cincinnati and Tschardjui, there is great advantage from the fact that any systematic errors in the regular stations will be more readily discovered. It is a fortunate coincidence that the observatory at Cincinnati happens to be precisely on the parallel of latitude chosen for this work, and it is, moreover, a matter for congratulation that Russia is ready and willing to aid in the undertaking, to the extent of establishing and superintending the station at Tschardjui.

The latest results from pendulum observations are with reference to changes of the force of gravity with elevation, and the derivation of a new formula for the length (L) of the seconds pendulum at the sea-level. From a discussion of over 500 stations the conclusion is reached that what is usually known as continental attraction amounts practically to nothing, and that in general the change of the force of gravity at any point on the earth's surface depends purely and simply on the Newtonian law of the inverse square of the distance. The introduction of a spherical function of the third order in the formula for L, alluded to before, foreshadows the determination of a different curvature for the northern and southern hemispheres of the earth; yet the coefficient appears so small that the inequality cannot as yet be safely predicted. The compression given is 1/297, and the equatorial value of the force of gravity is about 1/13,000 greater than that now accepted. The investigation of the relation between disturbances in the force of gravity and deviations of the plumb line is one of the most interesting problems of the near future.

Three matters of universal interest were brought before the Association, and suitable action was taken thereon. These were: (1) "The determination of the figure of the earth by the measurement of arcs and the determination of the force of gravity." (2) "The remeasurement of the Peruvian arc." (3) "The redetermination of the difference of longitude between Paris and Greenwich." The first two subjects were introduced as resolutions by the United States delegate, and brought out interesting discussions. The first was proposed for the sake of directing the attention of the Association more specifically to the prime object of its existence. No one doubts the utility or necessity of a complete study of the law governing the changes of latitude, but its ultimate bearing is rather one of astronomy than geodesy. The funds of the Association are now being devoted largely to the latitude question, and the time seemed fitting to suggest work more directly in the line of its avowed purpose—the measurement of the earth. The object of the resolution was, therefore, in the nature of a recall to the original conception of its being, and bespoke in the interest of pure geodesy an application of its resources to a realisation of the idea of its founders.

The remeasurement of the Peruvian arc now appears to be assured. It may be worth while just here to recall the essential features of this work. One hundred and sixty years ago, when it was a disputed question whether the polar or equatorial diameter of the earth was the longer, the French Academy decided to make one supreme effort to settle the point. To this end, two arcs were measured: one on the equator (now known as the Peruvian arc, although it is really in Ecuador); and the other in Lapland, as near the pole as possible. These two arcs, confessedly inaccurate in the light of modern geodesy, have been employed continually in the determination of the earth's figure. Situated as they are, near the extremities of the quadrant, their influence is great on the shape deduced, so that one of the pressing needs of the day in the measurement of the earth is a redetermination of their lengths. It is proposed to make a reconnaissance during the summer of 1899, report the results thereof to the Paris conference of 1900, and then decide definitely on the plans of final measurement. It is universally conceded that France should be given the first chance to act, not alone because the first measure was made by her, but also because the conference of 1889 relinquished in her interest further consideration of the subject.

The Russians and Swedes, in a quiet sort of way, are measuring an arc between the parallels of latitude $77\frac{1}{2}°$ and $81\frac{1}{2}°$ in Spitsbergen. The triangulation will require two summers and part of one winter, and will cost 100,000 kronen (5500*l.*), exclusive of cost of vessels furnished by the governments. The field work will be finished in 1900, and the computations two years later. Fifty stations will be occupied. The sides range in length from ten to one hundred and thirty kilometres, and the bases, of which there will be only two, are to be measured with Jaederin's steel tape line, twenty metres long.

The difference of longitude between Paris and Greenwich came up again for investigation. Nothing seems to remain but to study the conditions of the work of 1888 and 1892, and reconcile, if possible, the outstanding difference. The matter has been referred by the International Geodetic Association to the directors of the two observatories, and a definite result will, doubtless, soon be made known.

The variation of the latitude seems to be at present an absorbing question before the Association; and there results from action taken at the Stuttgart meeting the following status:—Six stations will be established during the summer of 1899 on the parallel of latitude 39° 8′. These will be distributed in longitude as follows: one each in Japan, Turkestan and Italy, and three in the United States. The American ones will be located at Gaithersburg, Md.; Cincinnati, O.; and Ukiah,

[1] Abridged from an official report by Mr. E. D. Preston to the Superintendent of the Coast and Geodetic Survey, published in *Science*.

Cal. This gives a preponderance of weight to the determination of the coordinate Y (X passing through Greenwich), but a station in Portugal, which may possibly be secured later, would essentially increase the accuracy of X. Tschardjui, in Russia, and Ukiah, in California, are nearly opposite, and Mizusawa, in Japan, is in the only remaining unoccupied quadrant. The scheme proposed is, therefore, a favourable one for the study of the motion of the pole. No one knows as yet how long it will be desirable to continue the observations. The period now provided for is five years, but it is proposed to buy the land upon which the observatories will be located, or lease it for one hundred years. It is evident that at least twenty-one years would be desirable, because during the seven years of observations already made the pole has returned nearly to its mean position, and three of these cycles should be completed before any definite idea can be had as to its mean path. The cost of the entire work will be about 2000*l.* annually. The visual method is to be followed regularly without, however, excluding the possibility of employing later the photographic one, which has already given excellent results. Twelve groups of stars, each comprising eight pairs, will be selected. Six pairs in each group are destined for the latitude determinations proper, while the two remaining pairs, having great zenith distances (about 60°), will, it is hoped, throw light on the question of refraction. The observing period for each night is four hours, and will vary from 7 p.m. to 3 a.m., depending on the situation of the group. The instrumental outfit will consist of a zenith telescope and astronomical clock for each station, except that of Japan. Here a chronometer will be substituted for the clock, on account of the frequency of earthquakes.

Although the object of the general conference was scientific discussion, a faithful historian cannot ignore the social and humanitarian side of the function. From our entrance into the beautiful capital of Wurtemberg until the time of our departure we were the recipients of the most cordial hospitality.

Before closing the present paper, attention should be called to a few points of interest noted during the trip to Stuttgart and return. A flying visit was made to the Royal Observatory at Berlin, the Reichsanstalt at Charlottenburg, and the Geodetic Institute at Potsdam. At Paris the offices of the geographic service and the International Bureau of Weights and Measures were examined, and part of one day was devoted to the English Ordnance Survey at Southampton.

An interesting object at the Berlin Observatory is the instrument with which Küstner discovered the variation of latitude; not alone because of the splendid result achieved, but on account of the conditions under which the work was done. It is mounted on a pier more than twenty feet above ground, on a subsoil of sand, in the middle of a city, with bad atmospheric conditions and about one hundred feet from the public thoroughfares. In spite of these adverse circumstances a new fact was added to science, which had baffled the efforts of larger telescopes under immeasurably better conditions. There is much encouragement in this to investigators with scanty means at their disposal.

At the Aichungs-Kommission a balance was shown which easily determines the weight of a kilogram with an error of 1/200 of a milligram, being 1/200,000,000 part of the quantity sought. They have also a complete series of weights in quartz from 1/2 gram to one kilogram, and thermometers giving the temperature by estimation to 1/1000 of a degree Centigrade.

At Charlottenburg the most striking feature was the extension and perfection of the organisation. Nine buildings in all, of which the two larger are devoted, one to theory and the other to practice, have cost, together with the running expenses since 1887, 3,000,000 marks. The annual outlay is at present about 18,000*l.*

The Geodetic Institute at Potsdam has been much less expensive, and presents many admirable points of arrangement and administration. Among the details may be cited: the clock room, always maintained at a temperature between 20° and 21° Centigrade; the pendulum room, artificially heated on all sides, including the floor; a pillar over fifty feet high, and correspondingly thick, with meridian marks several miles away, to study changes in azimuth and the movement of the earth's crust; and finally a small photographic instrument, by means of which the occupation of a station only requires eight minutes, and gives a determination of the geographical position in latitude within two seconds of arc. The subsoil, as at Berlin, is nothing but sand.

At Sevres, near Paris, several interesting instruments were seen, among which may be especially mentioned that designed for the comparison of the metre with the wave-length of light following Michelson's method, and the apparatus for the determination of coefficients of expansion according to the method of Fizeau. Some recent experiments have been made on a composition containing 36 per cent. nickel and 64 per cent. steel. It appears that the expansion from heat is thus reduced to about 1/50 of what we should expect from the individual components. This discovery will simplify enormously the solution of problems where the temperature question has thus far been the great difficulty. It will, for example, be a comparatively easy matter to make pendulum clocks run with a daily correction of about 1/10 of a second per day under varying temperature conditions.

MIRAGE.[1]

WHEN a ray of light passes from point to point of a medium which is everywhere similarly constituted, its path is a straight line; when it passes from one medium to another medium of different density, then the ray of light is refracted or bent at the surface which separates the two media. When the ray passes from one medium to another which is denser, the refraction or bending is always towards the normal to the surface separating the two media at the point of incidence; when, on the other hand, the ray passes from a medium of a certain density to one of less density, then the bending is always from the normal to the common surface at the point of incidence. The earth is surrounded with a spherical envelope of air, and if that air were always of the same density everywhere its refractive index would be the same, and there would be no terrestrial refraction. But the spherical envelope which surrounds the earth is not all of the same density, and the refractive index of the air varies with the density. There are two causes, in the main, which militate against the uniform density of the atmosphere; one is barometric pressure, and the other is temperature. Taking no account of temperature for the moment, taking merely as the cause barometric pressure, the density of the air diminishes gradually upwards from the surface of the earth, so that the refractive index of the air diminishes upwards. The diminishing of the refractive index is not absolutely proportional to the decrease of density, but it is found by experiment to be sensibly proportional to the excess of the density over unity. The circumstance of normal refraction in the British Isles, as regards temperature, is that there is a gradual diminution of temperature upwards at the rate of about 1/300° F. for every foot of ascent. As the air gets cooler the density increases, so the tendency is to some extent to counteract the effect of barometric pressure, but it does not altogether do so. The result in the normal refraction of the British Isles is that there is a gradual diminution of density upwards.

We may consider the air to be stratified in horizontal layers; as a matter of fact, it is stratified in spherical layers, but it will simplify matters to consider it stratified in horizontal layers, the more so as the sphericity of the earth, though it is a slight cause of terrestrial refraction, is not by any means the chief cause; terrestrial refraction would still exist if the earth had no sphericity, and if its surface were perfectly plane. I show you here a diagram representing the normal state of the atmosphere, and showing the curvilinear path taken by a ray of light when it passes from one point of such an atmosphere to another point horizontally distant from it. The reason a curved path is taken is this: supposing the ray to have a general direction upwards, and supposing it to have been inclined at incidence at a certain angle with the normal, as it is going from a medium—air—to air which is less dense, it bends away from the normal, and therefore there would be a successive bending away from the normal at each layer until finally the ray would arrive at the highest point in the diagram. Then, if it were to pass downwards, it would be passing from a medium of a certain density to one of a greater density, and it would approach the normal at each surface of separation of the media, and therefore its path would be a curved path presenting concavity downwards. A ray of light will actually take some such path, because by curving upwards it takes the path which it can pass over in the least time. Generally, a ray of light takes the minimum path as regards time, and it is found to curve up into the layers of air which are of less density, because it can traverse them with greater velocity. It is important to notice that a ray of light

[1] A lecture, delivered at the Camera Club, by Major P. A. MacMahon, F.R.S.

always presents the concavity towards the denser layers; and there is another principle, that the amount of curvature of the ray, *i.e.* the total bending that there is in the ray over a given length of ray, is directly proportional to the rate at which the density changes along the normal to the direction of the ray. For instance, if we take a vertical line, the normal to the direction of the ray is horizontal, and there is no change of density in that horizontal direction, and accordingly there is no bending of the ray; if, on the other hand, the general direction of the ray is horizontal, the normal to the ray is vertical, and that is the direction along which there is maximum change of density, and therefore in that case you will get maximum bending. We get, then, the two cases: when the ray is vertical there is no bending, no curvature; when the ray is horizontal you get maximum curvature; and for intermediate directions you get intermediate amounts of curvature.

I was first led to look into this subject by considerations which arise in discussing certain questions respecting artillery firing, and I propose to give you some results which I have obtained in order to show the effect of refraction upon artillery fire. A mile on the earth's surface subtends at the centre of the earth an angle of about 52″; the refraction will have a mean angle of about 4″, a minimum value of about $2\frac{1}{2}$″, and a maximum value of about 8″; and taking a range of three miles these values of the refraction would become 12″, about 8″, and about 24″ respectively; and very exceptionally the refraction would amount to about 1′ 18″. The meaning of this, in regard to artillery fire, is that (taking this exceptional amount of refraction), if the tangent sights of the gun were laid upon an object at that distance they would be really laid at an elevation 1′ 18″ too much, and correction for terrestrial refraction would consist in depressing the gun through an angle of 1′ 18″. That is not a very important matter from an artillerist's point of view, because guns can only be laid properly to within about 5′.

There is also the question of determining the range. That can be done from an elevation by an instrument called the depression range-finder. If we take the range of an object by means of this instrument the terrestrial refraction would give a longer range than we ought to have, and the necessary correction would diminish the found range.

I now come to other cases that may present themselves in the density of the air. The case that we have considered already is that of the temperature diminishing gradually upwards at the rate of 1/300° F. for every foot of ascent; in Great Britain the diminution is seldom more than about 1/130° or less than 1/400° F., but in other climates it is different. If the temperature were to fall at a more rapid rate the air would be very much more nearly of uniform density, and that would result in a smaller curvature of the ray. If the fall were at the rate of about 1/30° F. for every foot of ascent it would result in the density of the air being uniform, and there would be no terrestrial refraction at all. A more rapid fall of temperature still would cause a rise of air density upwards, and that would cause a curved ray with the concavity presented upwards. In such a case the refraction is said to be negative, whereas in the case that we had formerly the refraction is said to be positive. On the other hand, a rise of temperature upwards causes a rapid diminution in air density in ascending, and the ray with the concavity presented downwards is then more curved; and in the extreme case in which the rise of temperature upwards is at the rate of 1/16° F. for every foot, the curvature of the ray would be the same as that of the earth, and in that case—which, of course, would never actually present itself—we should be able to see completely round the globe, simply because the ray would encircle it. Again, climatic conditions may lead to another distribution of the density. There might be a gradual rise in density upwards to a certain stratum of maximum density, and then a diminution of density upwards, in which case the ray of light would pass in a curious sinuous path with the concavities presented towards the denser layers.

[Major MacMahon here enumerated conclusions, relating to terrestrial refraction in the plains of India, drawn from the experiments and observations of the late General J. T. Walker, R.E., formerly Superintendent of the Great Trigonometrical Survey of India, from which it appeared that the circumstances mainly affecting terrestrial refraction were in order of importance as follows: (1) The time of the day, (2) the temperature, (3) the aspect of the sky—whether cloudy or sunshine, and (4) the humidity of the air.]

Before proceeding to the next part of my subject, I will mention the well-known case of astronomical refraction—the circumstance that during a total eclipse of the moon the whole disc of the moon is not obscured, the fact being that the rays of the sun in passing through the atmosphere of the earth are refracted towards the normal, and in that way some light does get upon the surface of the moon.

I come now to that effect of extraordinary refraction which is more especially termed mirage, and which was first noticed, so far as we know, by the French army under Napoleon. The conditions favourable to mirage are generally a very hot sun and a sandy soil, which becomes very hot under the influence of the sun, and an almost total absence of wind. Under these circumstances there is an extraordinary amount of negative refraction, the rays are very much curved, and the concavity is presented upwards. An illustration which is familiar to everybody, because it occurs in many books on physics, is that in which the observer sees the top of a tree by means of a negatively-curved ray, and it accordingly appears to him to be in the direction of the tangent to the ray where it enters the eye; the other points in the tree he sees in other directions, and altogether the tree appears with an inverted image below it. Not only so, but where there is a very clear sky that also is refracted down, so that the tree appears in the midst of an inverted image of the sky, which has very much the appearance of water. This phenomenon is very common in Egypt. In Egypt there is very often a great quantity of sand with villages dotted about, these being somewhat raised in order to escape the periodical inundations of the Nile, and the effect to an observer is that of a number of raised villages in the midst of what appears to be an enormous lake. The illusion is increased by two circumstances: first, that by reason of the great heat of the sand there is a considerable convection of heated air upwards, which gives the air that peculiar rippling appearance, causing the refracted sky to look like ruffled water; and second, that the general direction of the ray is very similar to that of a ray reflected by a horizontal mirror placed upon the ground. This phenomenon is also common in Australia and in the plains of India, in the low-lying fen districts of England, and on the shingle ranges at Lydd.

One very curious thing about mirage is that it depends very much upon the position of the eye; a few inches in the height of the eye may make all the difference. I remember myself, on the plains of India, observing a mirage which was only evident when I was at a particular height; there was only a vertical space of two or three inches in which the effect could be seen, so that these phenomena may easily escape notice. A singular effect may sometimes be observed at a particular spot on the south coast, and very likely at other places; when the waves come in on to a very hot beach, if you place the eye within about a foot from the ground and look parallel to the wave-fronts, you can see an image of the wave two or three feet above the real wave. This may conceivably arise in this way: the wave may bring in some cold air, and if the wind were blowing a little off the heated beach there might be some heated air brought in as a layer above that cold air; that would give that rapidly diminishing density upwards which gives a ray with considerable curvature and with concavity presented downwards, and would certainly result in an image of the wave above the real wave.

I should like to mention a case of refraction observed on the artillery ranges at Lydd, which has given rise to some controversy. An officer was firing on a hot sultry day, from an ordinary Maxim machine gun at a target about 600 yards distant, and as the firing went on he saw a great wedge-shaped gap in the top of the target, and he thought that the hail of bullets had beaten down a part of the target. To his astonishment, however, when the firing ceased the gap disappeared, and the target appeared intact and undamaged. I imagine this to be an effect of mirage. I conclude that he was looking over the gun through the heated gases rising from the muzzle, which formed a medium of gradually increasing density upwards; he was observing the upper portion of the target through this medium, and I have no doubt that that caused negative refraction, bending the rays so that the sky above the target was seen in the shape of a wedge, something like the shape of the vertical section of the rising gases. I have discussed the matter with physicists, and some agree with me, but other physicists of note do not accept the explanation which I have given.

I now pass on to another part of the subject, which is called "looming." Distant objects are said to "loom" when they

appear in positions much higher than their actual positions, that is to say, when images of them appear considerably raised above their true positions. The effects of looming are very extraordinary, and I have some slides to show you which I have prepared from examples recorded by Commander William Scoresby, who went on his third voyage in his ship the *Baffin* to the Greenland whale fishery in the spring of 1822. The first of these views includes several large irregularly-shaped icebergs, which must cause very unusual distributions of air density, and gave rise to quite remarkable vertical and lateral refractions. In the second there are images of ice which was quite out of sight or quite beyond the horizon. There was extraordinary vertical magnification; small hummocks of ice were drawn out into spires, sometimes of a castellated shape and sometimes having the appearance of naked trees; at other times there appeared to be a city of ice, with public edifices, spires, &c., and Commander Scoresby states in his book that these effects were constantly changing, and were never the same for two minntes together. The first of these drawings, which you saw on the screen, showed a curious inverted image of a ship in the sky, raised considerably above the horizon; that ship was so distant that it could not be seen with a powerful telescope.

During the Crimean War observers on one occasion saw the whole of the British Fleet inverted at a considerable height, an illustration of which appeared in *The Illustrated London News* at the time. Some very interesting cases were recorded by Dr. Vince in the Bakerian lecture of 1798, read before the Royal Society, some of which are delineated in the succeeding slides. He remarks upon these curious phenomena that he thinks that in cases of national emergency certain people should be told off with telescopes to look out for the enemy's ships, and to search the horizon to see if they could detect any ships looming. Dr. Vince mentions another remarkable instance in which he saw Dover Castle from Ramsgate, at a point from which the whole of the keep of the castle cannot be seen, the four turrets only being visible. The most curious case of lateral refraction that I have been able to discover was observed at Geneva in 1818, by M. Jurine; a barque was seen approaching on the left bank of the lake, and at the same time an image of the sails was observed above the water, which, instead of following the direction of the barque, separated from it and appeared to approach Geneva by the right bank of the lake, the image moving from east to west while the barque moved from north to south. This case was brought to the notice of Biot, the physicist, and he, in one of the scientific journals, gave a very long explanation. He came to the conclusion, from the geographical features, and climatology, and the direction in which the sun's rays were passing at the time of the observation, that there would be considerable lateral difference in the temperature, quite sufficient to produce this phenomenon of lateral refraction.

Another case of curious refraction has been noticed by many people—I have seen it myself particularly on the coast of Norway. Low lands, and the extremity of headlands, or points forming an acute angle with the horizon of the sea, and viewed from a distance beyond it, appear elevated above it, with an open space between the land and sea, the effect being proportional to the amount of evaporation taking place at the surface.

Fata Morgana is a name given to an optical phenomenon sometimes seen in the Straits of Messina between Sicily and the Italian coast. Minasi says: "When the rising sun shines from that point whence its incident ray forms an angle of about 45° on the sea of Reggio, and the bright surface of the water is not disturbed either by wind or current, the spectator being placed on an eminence of the city with his back to the sun and his face to the sea, on a sudden there appear in the water various multiplied objects, namely, numberless series of pilasters, arches, castles, columns, towers, palaces with balconies and windows, valleys of trees, plains with herds and flocks, &c., in their natural colours and proper action, passing rapidly in succession along the surface so long as the above-mentioned causes exist. If, in addition, the atmosphere be highly impregnated with vapour and dense exhalations not previously dispersed by the action of the wind and waves, or rarefied by the sun—in this vapour, as in a curtain, to a height of 24 or 25 feet, and nearly down to the sea, the observer sees the same objects not only reflected from the sea, but likewise in the air, though less distinct. Lastly, if the air be hazy and slightly opaque and dewy, the objects appear only at the sea surface, but with prismatic colours." He endeavours to prove that they are representations of objects on the two coasts. He considers the sea an inclined speculum, on account of the rapid current which runs through the Straits, and divided into different planes by contrary eddies, and he ascribes the *aerial morgana* to the refractive and reflective power of matter suspended in the air.

Lastly, I would mention the experiments of Wollaston upon the subject of refraction and mirage. First, he says, into a square phial containing a little clear syrup put an equal quantity of water in such a way that it floats without mixing, and after a little time, by mutual penetration, you see effects; if you view through the syrup a card with a written word upon it, you see it, and also above it an inverted and erect image of the same. That is a case in which the density diminishes upwards, and the ray has its concavity presented downwards. Then, above the water he placed rectified spirits of wine, when the inverted and erect images were seen below, these appearances continuing many hours and even days, and he carried out similar experiments with water at different temperatures. Everybody knows the experiment with a red-hot poker; the effects of mirage can be seen by looking along the surface of a red-hot poker, held at a distance of about a foot from a sheet of paper, when there is perceptible refraction. Again, Wollaston looked along a horizontal plate of glass upon which he poured ether, and a line appeared instantaneously upon the opposite wall at an elevation of half a degree, this effect being due to the cold caused by the evaporation of the volatile liquid. Finally, Brewster showed that all the phenomena of unusual refraction might be observed by holding a heated iron over a mass of water bounded by parallel plates of glass, and then substituting a cold bod y for the hot iron.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE foundation-stone of the Gordon Memorial College at Khartum was laid on Thursday last by Lord Cromer, who remarked that the College would aim at diffusing knowledge of agriculture, engineering, and other practical acquirements useful to all classes.

THE New South Wales Government invite applications for the position of Professor of Physics in the University of Sydney, from University graduates under thirty-five years of age. Particulars of the conditions of appointment, duties, &c., can be obtained from Sir Daniel Cooper, Bart., G.C.M.G., Acting Agent-General for New South Wales, 9, Victoria Street, Westminster, London, S.W.

THE necessity of encouraging scientific investigation, and of providing means for training investigators, is pointed out by Prof. Cleveland Abbe in the U.S. *Monthly Weather Review* (September 1898). He remarks:—A mistaken idea has widely prevailed that the investigator is a genius, born and not made. The history of German science has, however, shown that environment and training are as important as birth and inheritance. The whole system of education in the German universities has for five generations been directed to the development of the investigator as its highest product. Those who discover important new facts, laws, or principles have been rewarded with the highest places in the intellectual world of that nation. Those who feel that they have a desire or calling for scientific research are encouraged to study for the degree of doctor of philosophy, a degree that is only granted when the candidate has, by actual observation, experiment, or exploration, made some important contribution to human knowledge. The professors under whom he studies have, in their turn, made many similar contributions, and are well prepared to judge of the value of *his* work. The German universities have, during the past seventy years, published over fifty-thousand so-called "doctors' dissertations," embodying the results of the works of fifty thousand candidates. The consequence is that to-day Germany easily leads all the world in the amount and value of her contributions to human knowledge and the energy with which her students pursue the study of nature.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, December 1898.—At the October meeting of the Society seven papers were communicated. Abstracts of the papers not to be published in the *Bulletin* are given.—Prof. Woodward's paper, on

the mutual gravitational attraction of two bodies whose mass distributions are symmetrical with respect to the same axis, deals with certain problems in the theory of Attraction which, although fairly accessible to treatment, seem to have been overlooked (some of the equations occur in Todhunter, "History of the Theories of Attraction and Figure of the Earth," vol. ii. p. 102).—A paper by Prof. Roe, on symmetric functions, considers the matter from two standpoints. The first part deals with the functions as a whole, and is mainly critical and historical. Part ii. treats of the individual terms of a symmetric function, together with their coefficients. Prof. Chessin applies the theory (which we have noted in the abstract of a paper previously read by him) to the problem of three bodies m_1, m_2, m_3, viz. when the mass of one of them (m_3) is infinitely small compared with the masses m_1 and m_2, while the eccentricity of the orbits of m_1 and m_2 is zero, so that these bodies move uniformly in concentric circles above their common centre of gravity. Such is very nearly the case of a small planet in the presence of the sun and Jupiter, and also very approximately the case of satellites.—Prof. Lovett's contact transformations of developable surfaces discusses the determination of the contact transformations which leave invariant the partial differential equation $| p_{11}, p_{22}, \ldots, p_{nn} | = 0$ (*cf.* Lie, Darboux and Mayer. Some of the results are complete generalisations of those of a memoir of G. Vivanti, *Rend. di Circ. Mat. di Palermo*, vol. v. 1891).—Concerning a linear homogeneous group in $C_{m,q}$ variables isomorphic to the general linear homogeneous group in m variables, is a paper which was read by Dr. L. E. Dickson at the August meeting. It is chiefly concerned with continuous groups, but its results are readily utilised for discontinuous groups. An analogous isomorphism is discussed in a paper presented recently to the London Mathematical Society.—A second locus connected with a system of coaxial circles, by Prof. T. F. Holgate, read at the same meeting, is a very interesting extension of a paper, by the same author, which was communicated to the Toronto meeting, November 1897.—Prof. Emch, of Biel, Switzerland, communicates a note, entitled "Reciprocal transformations of projective coordinates and the theorems of Ceva and Menelaos." The note is illustrated with diagrams. The author confines himself to the two above-named theorems and their connection with certain transformations of plane and space. The properties admit of multiplication, some of which have been discussed by Rosace and Steiner.—The "notes," as usual, contain a good deal of information useful to mathematical students.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 15, 1898.—"Note on the Densities of 'Atmospheric Nitrogen,' Pure Nitrogen, and Argon." By William Ramsay, F.R.S.

It is concluded that the density of "atmospheric" nitrogen is correctly given as the mean of the densities of the constituents, taken in the proportion in which they occur.

Chemical Society, Dec. 15, 1898.—Prof. Dewar, President, in the chair.—The following papers were read.—The interaction of ethylic sodiomalonate and mesityl oxide, by A. W. Crossley. Mesityl oxide and ethylic sodiomalonate do not condense in the expected manner, but the product on hydrolysis yields a diabasic acid, $C_{16}H_{24}O_4$ melting at 148–148°·5; derivatives of this acid are described.—The interaction of ethylic malonate and acetylene tetrabromide in presence of sodium ethoxide, by A. W. Crossley. Ethylic disodiomalonate and acetylene tetrabromide react with evolution of acetylene and formation of tribromethylene and tetrethylic acetylenetetracarboxylate.—Derivatives of camphoric acid: Part iii., by F. S. Kipping. A number of compounds obtained from π-bromocamphoric acid are described.—Synthesis of αββ-trimethylglutaric acid, by W. H. Perkin, jun., and J. F. Thorpe. Ethylic sodio-α-cyano-ββ-dimethylglutarate is obtained by the interaction of ethylic cyanacetate, ethylic dimethylacrylate and sodium ethoxide; methylic iodide converts it into ethylic α-cyano-αββ-trimethylglutarate which on hydrolysis gives αββ-trimethylglutarimide. This imide yields αββ-trimethylglutaric acid, $COOH.CHMe.CMe_2.CH_2.COOH$, when heated with hydrochloric acid.—Hydrolysis of methylic and ethylic γ-cyanoacetoacetates and their derivatives, Part i., by W. F. Lawrence. Methylic γ-cyanodimethylacetoacetate is hydrolysed by hydrochloric acid with formation of αα-dimethyl-β-hydroxyglutaconic acid, $COOH.CH:C(OH).CMe_2.COOH$; this, on reduction with hydriodic acid, yields αα-dimethylglutaconic acid.

Geological Society, December 21, 1898.—W. Whitaker, F.R.S., President, in the chair.—On a Megalosauroid jaw from Rhætic beds near Bridgend, Glamorganshire, by E. T. Newton, F.R.S. The specimen which forms the subject of this communication was obtained by Mr. John David of Porthcawl, and it has been presented to the Museum of Practical Geology. It was derived from beds low down in the Rhætic series, which may eventually have to be included in the upper part of the Keuper. The specimen does not admit of exact comparison with *Megalosaurus*, and it is named as a new species of *Zanclodon*—a genus in which the author is also inclined to place some forms described under the names of *Palaeosaurus*, *Cladyodon*, *Avalonia*, and *Picrodon*.—The torsion-structure of the Dolomites, by Maria M. Ogilvie [Mrs. Gordon]. The paper opens with a general account of the work of Richthofen, Mojsisovics, Rothpletz, Salomon, Brögger, the author, and others on the Dolomitic area of Southern Tyrol. It then gives the results of a detailed survey recently made by the author of the complicated stratigraphy of the rocks of the Gröden Pass, the Buchenstein Valley, and the massives of Sella and Sett Sass; together with the author's interpretation of these results, and her application of that interpretation to the explanation of the Dolomite region in general. The author concludes that overthrusts and faults of all types are far more common in the Dolomites than has hitherto been supposed. The arrangement of these faults is typically a *torsion*-phenomenon, the result of the superposition of a later upon an earlier strike. This later crust-movement was of Middle Tertiary age, and one with the movement which gave origin to the well-known Judicarian-Asta phenomena. The youngest dykes (and also the granite-masses) are of Middle Tertiary age, while the geographical position of both is the natural effect of the crust-torsion itself. This crust-torsion also fully explains the peculiar stratigraphical phenomena in the Dolomite region, such as the present isolation of the mountain-massives of dolomitic rock. After discussing in detail the structure of various areas, the author applies her results to the interpretation of the complexities of the Judicarian-Asta region of the Dolomites in general, and also to the explanation of the characteristic structural forms of the Alpine system as a whole.

Royal Microscopical Society, December 21, 1898.—Mr. E. M. Nelson, President, in the chair.—The President exhibited a new objective by Carl Zeiss, called a "Plankton-searcher," a low power water immersion objective, designed for use in examining living objects in water, the definition of which was exceedingly sharp. He also exhibited an erecting eye-piece fitted with Porro's prisms, another new appliance produced by the same firm, which would be found useful for dissecting and other purposes.—Mr. Keith Lucas exhibited and described a new model microscope, the design of which was to effect the coarse and fine adjustments by means of a single slide, thereby reducing the expensive work of planing.—The President directed attention to some of the various types of binocular microscopes that were exhibited: among those referred to were Ahrens' binocular eye-piece, in which both tubes were equally inclined, and a microscope by Murray and Heath, one tube only being inclined, the other lying in the optical axis of the instrument, the construction being similar to that of Nachet; these two instruments were exhibited by the Society.—There was a new binocular dissecting microscope by Leitz, exhibited by Messrs. Watson and Sons, consisting of two Brücke lenses fitted on a bar by jointed attachments so that the distance between the tubes could be adjusted to suit the eyes. This was likely to prove valuable for examination of objects, or for dissection under low power.—Attention was directed also to a form exhibited by Carl Zeiss, made with Porro's prisms, giving an erect image; this microscope is provided with two objectives of equal power, one for each tube, the stereoscopic effect being greater than that obtained by a divided image from one objective.—Messrs. Powell and Lealand exhibited their high-power binocular prism in conjunction with a 1/20-inch apochromatic objective.—A Mojinie's portable binocular, a Nelson model, Wenham's binocular with a high power objective, a binocular microspectroscope, were exhibited, besides various patterns of Stephenson and Wenham binocular microscopes by Messrs. Chas. Baker, R. and J. Beck,

J. Pillischer, Swift and Son, and Watson and Sons.—Among the other objects exhibited may be mentioned typical species of Foraminifera selected from various localities by Mr. A. Earland, which were rare and beautiful; and mounted specimens of Hydrozoa, by Mr. G. E. Harris.

EDINBURGH.

Royal Society, December 19.—Lord Kelvin in the chair.—Mr. R. G. Alford read a paper on crane scaffoldings, their mathematical calculations and probable theoretical deficiencies. The paper was a comparison of two similar scaffoldings, one of which was overturned in a gale which the other resisted.—In a note on dew bows, Drs. Knott and Lundie gave an account of a system of brilliant "bows" produced at night on the ground, the source of light being the gas-lamp or electric light of the street. The phenomenon required the existence on the ground of a layer of numerous globules of water of nearly the same size and so small as to suffer little distortion from perfect sphericity. The globules were fog particles, which had gradually settled down in the still air of the last of four days of heavy fog. The curves formed by these dew bows are plane sections of a toroidal surface. Some of the curves were drawn on a black board by means of a simple but obvious kinematical model.—Lord Kelvin communicated a paper on the reflection and refraction of solitary plane waves at a plane interface between two isotropic elastic mediums, fluid, solid, or ether. The investigation presented certain novelties of treatment. One of these was the introduction of the condensational-rarefactional waves of reflection and refraction moving with slow velocities through the (contractile) ethers. (The *four* waves into which a wave of either type breaks up at the boundary of two elastic solids were first discussed by Knott in 1888, with special reference to earthquake waves.) Then there was the question of the total reflection of a solitary wave instead of a train of waves. And finally there was the application of the principle of the continuity of the rotational magnetic force at the interface. Fresnel's *sine* and *tangent* formulæ for the reflection of plane polarised rays followed at once.—Mr. Sydney A. Kay communicated a paper on the equilibrium between sulphuric acids and sulphates in aqueous solutions. The concentrations of the free acid, neutral sulphate, and acid sulphate in solutions containing sulphuric acid and a neutral sulphate were determined by means of a reaction velocity method—namely, by the catalysis of ethylic acetate. Then the degrees of dissociation in the three substances were calculated from Kohlrausch's later determinations of the electric conductivities at infinite dilution. Finally an expression for the equilibrium was developed as an empirical formula which, within the limits of the experiments, gave results in close agreement with observation. The formula was

$$\frac{\{\text{Conc. } H_2SO_4(1-\alpha_1)\}^{0.85}}{\text{Conc. } MHSO_4(1-\alpha_2)} = \frac{A}{\{\text{Conc. } M_2SO_4(1-\alpha_3)\}^x}$$

where conc. means concentration, M is the symbol for the metal involved, α_1 α_2 α_3 are the degrees of dissociation, A and x are constants with characteristic values for each case. Thus, when M is potassium, sodium or lithium, A has corresponding values 0·259, 0·0618, or 0·0600 respectively, and x has values 1, 1·35, 1·35 respectively.—Mr. David Robertson read a paper on dust figures of electrostatic lines of force. These were obtained by sprinkling the dust over a glass plate against the under surface of which were pressed electrodes in connection with a Wimshurst machine. The chief difficulty was to get a suitable substance; for the particles should be sufficiently conducting to be acted on inductively, and yet sufficiently insulating to prevent escape of the charges. Of the many kinds of dust tried, pure mahogany sawdust coloured with ink was found to be the most efficient. It was stated that the secret of getting good results lay in stopping the action of the machine at the right moment. Many interesting examples of the curves were exhibited.—In a note on the action of persulpates on iodine, Dr. Hugh Marshall drew attention to a reaction which seems to have been neglected by recent experimenters. When, for example, a solution of potassium iodide is being boiled with ammonium persulphate so as to decompose it and drive off the iodine by sublimation, the iodine in the liquid seems to disappear at a more rapid rate than corresponds to the amount volatilised. In fact, as was proved by direct experiment, the iodine is oxidised by the persulphate, and becomes iodic acid.—A paper by Prof. Anglin, on the summation of the series whose nth terms are u_n and $1/u_n$ where u_n denotes

$$(an+b)\{a(n+1)+b\}\{a(n+2)+b\}\ldots\{a(n+r-1)+b\}$$

was also read.

PARIS.

Academy of Sciences, January 2.—M. van Tieghem in the chair.—On the estimation of phosphorus and sulphur in plants and their ashes, by M. Berthelot. Of the various methods suggested for determining sulphur and phosphorus in plants, burning in a stream of oxygen, and subsequently passing the gases over a long column of red-hot sodium carbonate, gave the highest results. Prolonged boiling with strong nitric acid or estimation after incineration showed large deficiencies in both sulphur and phosphorus.—On the presence and estimation of chlorine in plants, by M. Berthelot. Combustion with oxygen in presence of sodium carbonate gave higher results than a careful incineration in the ordinary way. An attempt was made to distinguish between the total chlorine and the chlorine existing in the plant in the form of chlorides, but without much success.—Preparation and properties of an organic ammonium, lithium—monomethylammonium, by M. Henri Moissan. Anhydrous methylamine reacts vigorously with lithium at temperatures near 0° C., forming a blue solution similar to the alkaline ammoniums. The composition approximated to Li$(CH_3.NH_2)$. In a vacuum this loses methylamine, and finally deposits brilliant crystals of metallic lithium, no gas being evolved.—Influences of metallic armatures upon the properties of mortars, by M. Considère.—Constitution of the ring of small planets, by M. Jean Mascart. Curves are given showing the distribution of longitudes of the nodes and perihelia of the asteroids for every 30°.—Observation of the total eclipse of the moon of December 27, 1898, made at the Observatory of Lyons, by M. Ch. André. The state of the sky interfered considerably with the observations.—Observations made at the Observatory of Toulouse during the eclipse of December 27, 1898, by MM. Baillaud, Bourget, Montangerand, Rossard, and Besson, by M. Baillaud. Ten photographs were successfully taken during the eclipse.—Observations of the Brooks comet (October 1898) and Chase comet, made at the Observatory of Toulouse with the Brunner equatorial, by M. F. Rossard.—On the propagation of liquid waves through water, by M. Georges Poisson.—On the absorption of light by a body placed in a magnetic field, by M. Auguste Righi. When such gases as nitrogen peroxide, iodine, iodine monobromide, iodine monochloride, or selenium tetrabromide of suitable concentration are placed in the path of a ray of light in a strong magnetic field, a distinct change in the colour of the transmitted light is noticeable when the electromagnetic circuit is completed.—On a simple form of magnetometer, by M. A. Guillet. Two diagrams of the apparatus are given, together with the theory of the instrument, but no actual measurements are cited.—General method of separation of chlorine, bromine and iodine in the form of silver salts, by M. H. Baubigny. The dry silver salts are treated with sulphuric acid containing bichromate, the chlorine and bromine distilled off into potash containing sulphite, and these separated by the use of potassium permanganate and copper sulphate. The two test analyses given are very satisfactory.—On the formation of the head of the Hymenoptera, by M. L. G. Seurat. The head is formed uniquely from the head of the larva; at first invaginated, this head, by a movement of rotation in the median plane, becomes devaginated and acquires its final form.—A transverse section of the Briançon Alps, from Gironde to the Italian frontier, by MM. Kilian and Lugeon.—Ostioles in the animal and vegetable kingdoms considered as a regulating apparatus, by M. J. J. Andler.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 12.

MATHEMATICAL SOCIETY, at 8.—On a Determinant each of whose Elements is the product of k Factors: Prof. W. H. Metzler.—Properties of Hyper-space, in relation to Systems of Forces, the Kinematics of Rigid Bodies, and Clifford's Parallels: A. N. Whitehead.—A Simple Method of Factorising Large Composite Numbers of any unknown form: D. Biddle.—Zeroes of the Bessel Functions (second paper): H. M. Macdonald.—Linear Substitutions and Inversions: Dr. G. G. Morrice.—On the Reduction of a Linear Substitution to its Canonical Form: Prof. Burnside, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, JANUARY 13.

ROYAL ASTRONOMICAL SOCIETY, at 8.—A Suggestion for the Explanation of Stationary Radiant Points of Meteors: Prof. H. H. Turner.—Remarks on Prof. Turner's Paper, with another Suggested Explanation of Stationary Radiant Points of Meteors: Prof. A. S. Herschel.—Observations of the Leonids, November 1898: Observatory, Perth, West Australia.—On the Value of Possible Observations from Free Balloons: Rev. J. M. Bacon.—Note on Dr. Gill's paper "On a New Instrument for Measuring Astrophotographic Plates: Prof. H. H. Turner.—Note on Mr. Espin's Object in *Perseus*: C. D. Perrine.—Eclipse of the Moon, December 27, 1898: Rev. W. Sidgreaves.—The Great Sun-spot of September 1898: W. H. Robinson.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Application of the Science of Mechanics to Engineering Practice: Dr. Archibald Barr.

MALACOLOGICAL SOCIETY, at 8.—Notes on the Anatomy of some Snails (*Trachycystis*, *Dorcasia* and *Isomeria*): W. Moss and W. Mark Webb.—Illustrations of, with Notes on, some Non-Marine Hawaiian Molluscs: E. R. Sykes.—Description of New Non-Marine Molluscs from the Hawaiian Islands: C. F. Ancey.—Note on *Voluta Roadknightiae*: Agnes Kenyon.

MONDAY, JANUARY 16.

SOCIETY OF ARTS, at 8.—Bacterial Purification of Sewage: Dr. Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—Personal Experiences in China: Rev. Gilbert Reid.

VICTORIA INSTITUTE, at 4.30.—Glacial Action in the Southern Hemisphere.

TUESDAY, JANUARY 17.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—General Account of his Zoological Expedition to the South Seas: Dr. Arthur Willey.—On the Characteristic Points in the Cranial Osteology of the Parrots: Prof. D'Arcy W. Thompson, C.B.—Report on the Gorgonacean Corals collected by Mr. J. Stanley Gardiner at Funafuti: Miss Isa L. Hiles.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Effects of Wear upon Steel Rails: William G. Kirkaldy.—On the Microphotography of Steel Rails: Sir William C. Roberts-Austen, K.C.B., F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—On some New Half-tone Screens of English Manufacture: J. E. Johnson.

ROYAL STATISTICAL SOCIETY, at 5.

WEDNESDAY, JANUARY 18.

SOCIETY OF ARTS, at 8.—Canals and Inland Navigation in the United Kingdom: L. F. Vernon Harcourt.

GEOLOGICAL SOCIETY, at 8.—Felsitic Lavas and Tuffs near Conway (North Wales): Frank Rutley.—The Geology of Southern Morocco and the Atlas Mountains: the late J. Thomson.

ROYAL METEOROLOGICAL SOCIETY, at 7.45.—Annual General Meeting.—Address by the President (Mr. F. C. Bayard), on the Government Meteorological Organisations in various parts of the World.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Presidential Address.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.—Address by the President, Mr. Roland Trimen, F.R.S.

THURSDAY, JANUARY 19.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Observations upon the Normal and Pathological Histology and Bacteriology of the Oyster: Prof. Herdman, F.R.S., and Prof. R. Boyce.—On the Formation of Multiple Images in the Normal Eye: S. Bidwell, F.R.S.—On the Vibrations in the Field round a Theoretical Hertzian Oscillator; Prof. K. Pearson, F.R.S., and Miss Lee.—On the Refractive Indices and Densities of Normal and Semi-normal Aqueous Solutions of Hydrogen Chloride, and the Chlorides of the Alkalies: Sir J. Conroy, F.R.S.

ROYAL INSTITUTION, at 3.—Tibet and the Tibetans: A. H. Savage Landor.

SOCIETY OF ARTS (Indian Section), at 4.30.—Railways in Burma, and their proposed Extension across Yunnan: J. Nisbet.

LINNEAN SOCIETY, at 8.—New Peridiniaceæ from the Atlantic: G. R. Murray, F.R.S., and Miss F. G. Whitting.—On the Structure of Lepidostrobus: Arthur J. Maslen.—Some Observations on the Caudal Diplospondyly of Sharks: Dr. W. G. Ridewood.

CHEMICAL SOCIETY, at 8.—Researches on Moorland Waters I. Acidity: W. Ackroyd.—α-ketotetrahydronaphthalene: Prof. F. S. Kipping, F.R.S., and Alfred Hill.—A New Method for preparing *as*-dimethyl- and Trimethyl-succinic Acids: William A. Bone.—Reduction of Optically-active Mono- and Di-alkyloxysuccinic Acids from Malic and Tartaric Acids: Prof. Thomas Purdie, F.R.S., and William Pitheathly.—Action of Ammonia on Ethereal Salts of Organic Bases: Dr. Siegfried Ruhemann.—Esterification Constants of Substituted Acetic Acids: Dr. J. J. Sudborough and Lorenzo L. Lloyd.—Di-ortho-substituted Benzoic Acids. Part IV. Formation of Salts from Di-ortho-substituted Benzoic Acids and different Organic Bases: Lorenzo L. Lloyd and Dr. J. J. Sudborough.—The Thermal Effects of Dilution: J. Holmes Pollok.—The Changes of Volume due to Dilution of Aqueous Solutions: F. B. H. Wade.

FRIDAY, JANUARY 20.

ROYAL INSTITUTION, at 9.—Liquid Hydrogen: Prof. J. Dewar, F.R.S.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Epidemic Cerebro-spinal Meningitis: Dr. Bruce Low.

QUEKETT MICROSCOPICAL CLUB, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Results of Rain, River and Evaporation Observations made in New South Wales during 1897: H. C. Russell (Sydney).—Iowa Geological Survey Annual Report, 1897, &c. (Des Moines).—The Last Link: E. Haeckel (Black).—Annual Report of the Smithsonian Institution, to July 1896 (Washington).—Geographical Journal, Vol. xii. (Stanford).—Notes from a Diary in Asiatic Turkey: Lord Warkworth (Arnold).—The History of Mankind: Prof. F. Ratzel, translated, 3 Vols. (Macmillan).—The Swastika: T. Wilson (Wesley).—Mathematical and Physical Tables: J. P. Wrapson and W. W. H. Gee (Macmillan).—Bush Fruits: Prof. F. W. Card (Macmillan).—Elementary Mathematics: J. L. S. Hatton and G. Bool (Whittaker).—Studien über Hirsche: Dr. H. Nitsche, Heft 1 (Leipzig, Engelmann).—Grundriss einer Geschichte der Naturwissenschaften: Dr. F. Dannemann, ii. Band (Leipzig, Engelmann).—Maryland Geological Survey, Vol. 2 (Baltimore).—The Geology of the Isle of Purbeck and Weymouth: A. Strahan (London).

PAMPHLETS.—A Course of Lectures on Mining. I. The South Wales Coal-field: Prof. W. Galloway (Cardiff).—The Gypsum Boulder of Great Crosby: T. M. Reade (Liverpool).

SERIALS.—Journal of Botany, January (West).—Middlesex Hospital Journal, December (London).—Journal of the Royal Agricultural Society, December (Murray).—Journal of the Royal Statistical Society, December (Stanford).—Reliquary and Illustrated Archæologist, January (Bemrose).—Zeitschrift für Physikalische Chemie, xxvii. Band, 4 Heft (Leipzig).—Transactions of the Wagner Free Institute of Science of Philadelphia, April (Philadelphia).—Observatory, January (Taylor).—Scribner's Magazine, January (Low).—Geographical Journal, January (Stanford).—Knowledge, January (Witherby).—Journal of Anatomy and Physiology, January (Griffin).—Engineering Magazine, January (222 Strand).—Photogram, January (Dawbarn).—Monthly Weather Review, September (Washington).—Annuario Storico Meteorologico Italiano, Vol. 1, 1898 (Torino).—Mind, January (Williams).—Zeitschrift für Wissenschaftliche Zoologie, lxv. Band. 2 Heft (Leipzig).—Botanische Jahrbücher, Fünfundzwanzigster Band, 5 Heft (Leipzig).—Atlantic Monthly, January (Gay).—Imperial University, College of Agriculture, Bulletin, Vol. iii. No. 5 (Komaba).

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